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PRODUCT ENGINEERING

FEB 29 1931

Devoted to Product Creation, Design and Improvement
A McGRAW-HILL PUBLICATION

+ MARCH 1931 +

Price 25 cents

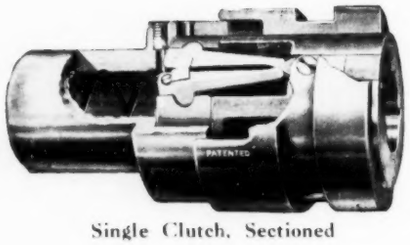
FAILURE—or immediate revamping of equipment—were the two alternatives facing the motion picture industry in 1927 when sound pictures were introduced + Under stress of public demand, new machines and new methods had to be developed almost overnight + The situation was one that only engineers could meet + What happened in the motion picture industry is not extraordinary—it may happen in any industry at any time

The Johnson Friction Clutch Is Being Used As A Part Of This Machine

ON THIS NEW

SIX-HEAD ELECTRIC WIRE SEALING MACHINE

(IN THE FOOD INDUSTRY)



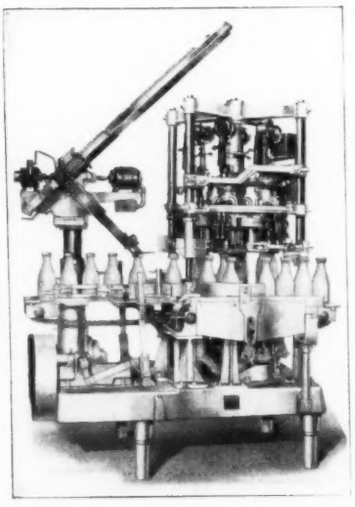
Single Clutch, Sectioned

The Sealing Machine shown below is equipped with a No. 2 Single **JOHNSON** Clutch, alemite lubricated and with a spur gear on the clutch hub. Perfect balance, smooth running, dependability and exactness in performance of this **JOHNSON** Clutch, provides satisfactory power transmission for this large Sealing Machine, which has a capacity up to 80 bottles per minute.

We would like to have you, Mr. Product Engineer, try the **JOHNSON** Clutch on your particular type of machine. Take advantage of over 27 years of our clutch manufacturing experience and the popular sales appeal of machines **JOHNSON Clutch equipped.**

On our New SUPER-JOHNSON Type of Clutch the working parts are enclosed. The expansion ring is faced with a special heat resisting material for high speeds, heavy loads, where excessive slipping is encountered and for excessive engaging per hour or day—and the features of Safety, Cleanliness, Quietness and Compactness (one size as small as 3⅝ in. dia.), *are powerful sales features.*

Single Clutch with Spur Gear on Hub used on this machine



Courtesy—Standard Cap & Seal Corp., Chicago, Ill.

WRITE FOR CATALOG "PE—3"

THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONN.

PRODUCT ENGINEERING

Devoted to the Interests of Engineers and Executives Responsible for Product Creation, Design and Improvement

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LOOKING INTO THE FUTURE

This is not Television. The look is only a few months ahead—May 1931 to be exact.

This glimpse forward is of importance to the readers of Product Engineering because—

1. It deals with actual sales successes.
2. Sales successes achieved through the work of Product Engineers.
3. Sales successes in a period of depression when only improved products, products planned to meet the requirements of the day, could achieve the swing into sales volume.

In brief the May issue of PRODUCT ENGINEERING will be devoted to sales successes of 1930 resulting from product development in 1929.

The Editors will analyze the various machines from the underlying motives of what prompted the developments involved, how the engineering objectives were achieved, the parts and materials involved in the selections, and the results obtained from both the product and the sales angles.

The machines to be described include the fields of transportation, metallurgy, textiles, dispensing, commercial and domestic equipment.

Look forward to the May

PRODUCT ENGINEERING

PRODUCT ENGINEERING

A McGRAW-HILL PUBLICATION MARCH 1931 VOLUME TWO, NUMBER THREE

FOUR CAMERAS and a beam microphone, examples of the completely redesigned equipment necessary for sound pictures, are here focussed upon desert scenes of "Beau Ideal"

WHEN THE DESIGNER ENCOUNTERS AN INDUSTRIAL TRANSFORMATION

By GORDON S. MITCHELL

Engineer, Sound Department, Universal Pictures Corporation

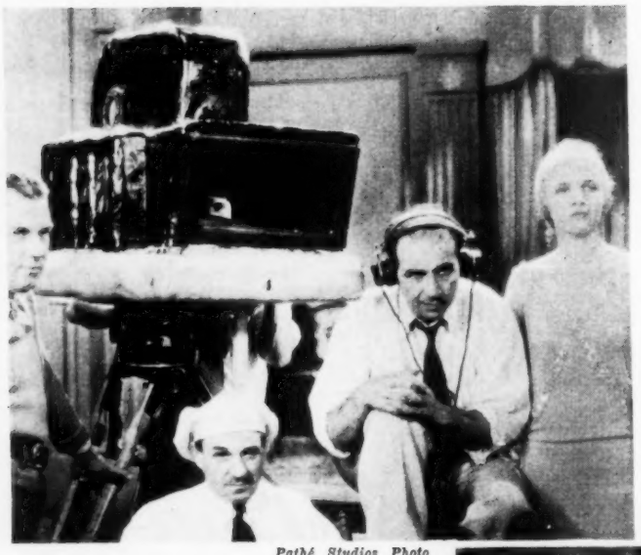
Any day in any industry—Pasteurization brought milk control and inaugurated a mechanized industry; hydrogenation forced development of entirely new chemical equipment—Here an engineer "on the inside" tells how sound pictures put the product engineer into the motion picture industry

THE motion picture industry, growing and advancing by leaps and bounds, entered the year 1927 with a feeling of self-satisfaction which was to be shattered rudely before that year was up. The arrival of recorded, synchronized sound with motion pictures was the signal for a concentrated upheaval, the like of which had never before been experienced by such an extensive industry. The entire method of making motion pictures was changed; old ways were suddenly found to be entirely wrong.

Many problems confronted studio engineers when sound was introduced to the motion picture world. The public thinks primarily of the effect of the introduction of sound upon the actors and the actresses. However, technical adaptations which became necessary because of recorded sound and dialogue were of sufficient numbers and magnitude to stagger an industry less fitted to conform to sudden changes.

GUIDE ROLLER bracket used on Mole-Richardson microphone "booms"

For example, the ordinary motion picture camera developed considerable noise within itself. There had been no necessity for quiet in its operation, all efforts being centered upon obtaining fast motion of the parts, with reliable action which would eliminate the possibility of buckling of film within the camera and consequent expensive delays in production. Suddenly, extraneous noise assumed a place of prime importance.



Pathé Studios Photo

AN EARLY "BLIMP," taken during the filming of "Her Private Affair," starring Ann Harding

known as "horseblankets," offered few advantages. Sound recording simultaneously with photography limited the cameraman in many ways, for many of the things which he used to enhance his photography in the days of silent pictures were now impossible. Sound and sight perspective were hard to match. Rotating shots and certain pan shots common in silent photography seemed impossible. Recording with a stationary microphone and photographing with a moving camera simultaneously results in a bad perspective. It was impossible to change focus while shooting with the horseblanket. The cover had to be removed, the focus changed and the cover replaced, with operations delayed in the meantime. Further, the microphone had to be kept some distance away or camera noise would be picked up.

A STEP FURTHER in "blimp" development and an early microphone "boom," during the filming of "We, We, Marie"

Universal Pictures Photo

It became necessary to devise means for eliminating camera noise in its entirety before truly successful recording of dialogue was possible.

The problem was attacked from as many different angles as there are studios, each group of sound technicians working out its own ideas. In the early days of sound recording, the cameras were placed within huge boxes, contemptuously known as "refrigerators" among the cameramen. They measured approximately 4x6 ft. in floor area, and varied in height from 4 to 8 ft., depending upon the type of action being photographed. The cameraman was stationed within the box, and the camera "shot" through an optical glass door in its front. Being of necessity soundproof, these boxes were hot and airtight. Needless to say, cameramen registered disgust with sound and all that pertained to it when it became necessary for them to crawl into their refrigerators at the beginning of a "take." The low boxes, built to accommodate a camera on a low tripod, were especially deprecated, it being necessary for the cameraman to lie flat upon his stomach. The refrigerators were built upon rubber-tired wheels to facilitate movement in "pan" shots.

The large boxes were soon replaced with a heavy padded quilt fastened with snaps or "zippers," and cut to enfold the camera completely except in front of the lens. These covers,

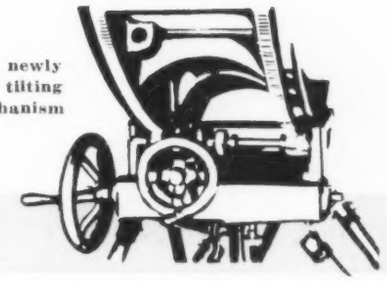
The next step in the evolution was a box quilt to fit around the camera, a great improvement for both cameraman and sound recorder. Plywood or Masonite cases lined with sponge, live rubber, or any and all sound absorbents and sound insulators, were tried in the search for suitable materials with which to construct a "blimp." Out of the host of experimental models there developed the Warner Brothers blimp, constructed of

aluminum and celluloid, lined with insulating felt or lead. The removable top and sides make it possible to get at any desired part of the camera without removing it from the blimp. This blimp is proving satisfactory for outdoor recording when it can be used several feet from the microphone. The regular tripod is used, being of sufficient strength to accommodate the small additional weight, but vibration transmitted through the tripod to the floor and picked up by the microphone make this blimp unsuited for indoor recording.

The Academy of Motion Picture Arts and Sciences, an association within the industry for the advancement of motion pictures in every branch, carries on investigation and development work along technical lines. The Academy technical committee conducted a survey to combine the good points of the blimps in use at various studios into one standard "super-blimp." This survey resulted in the blimp now in use. L. E. Clarke, of the Sound Department at Pathé Studios, is responsible for much of the blimp development work.

The blimp, were it to fulfill all requirements, had to impose no change in the relative position of the aperture, finder, or other component parts

THE PATHE "BLIMP" which won first prize in the awards of the Academy of Motion Picture Arts and Sciences



CLOSE-UP of the newly developed "M-R" tilting and "panning" mechanism

of the camera. It had to impose no restrictions upon the artistic leanings of the cameraman. Accurate lateral and vertical control was necessary for moving shots, and automatic fade-in and fade-out, as well as other necessary adjustments, were required outside the blimp in order that they might be manipulated during "shooting." An automatic motor control was desirable to shut the motor off in case of a film buckle or jam. An easily manipulated gear arrangement, as well as a universal joint by means of which the camera might be swung in any direction, was also necessary.

After all of the requisite properties of the "super-blimp" had been determined, the actual work of design and construction was begun. The blimp itself is built around two sets of angle-iron frames, the inner set supporting a 1/16-in. shell of sheet lead. The outer shell is built of aluminum. Between the two is a ¾ in. of "Akoustikos felt." The inner surface of the blimp is surfaced with black Kribble cloth to give a clean inside working face. The angle-iron frames give rigidity which insures tight fitting doors. Side and back doors are built of the same laminated construction except that flat iron framework takes the place of the angle iron. Door edges and jambs are fitted with live rubber, giving a rubber-to-rubber seal approximately 2½ in. thick. Compression hooks on the doors, with a mechanical advantage of 16 to 1, press the doors tightly into the frame, thus a 50-lb. pull on the hooks results in a pressure of 800 lb. per sq.in. upon the rubber surface of the door jambs. The camera shoots through an optical glass sheet mounted in a removable door, and the cameraman is enabled to make his adjustments at the front of the camera. The finder is mounted in the usual manner.

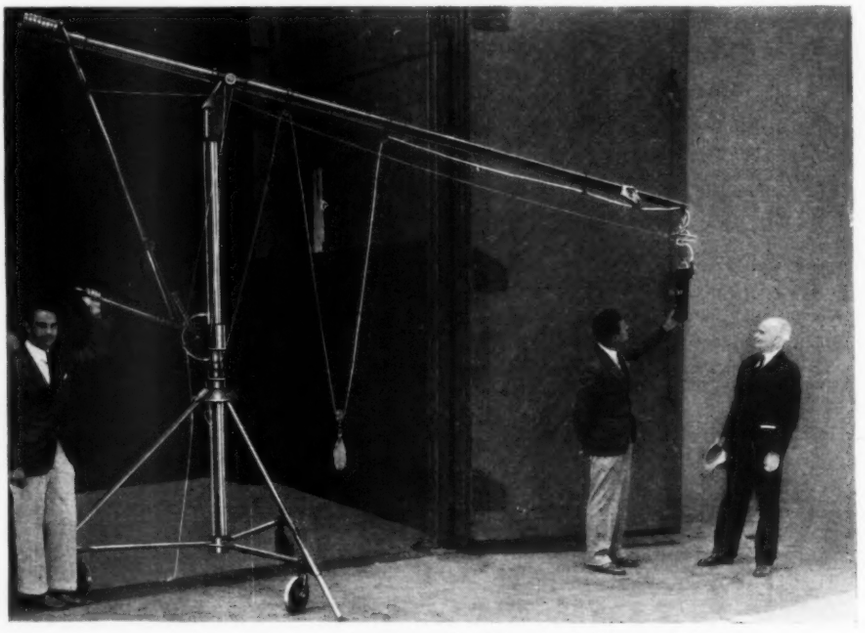
A mounting inside the blimp for the camera was a difficulty particularly hard to overcome. Many mountings were tried out and discarded either because they were too rigid and transmitted camera noise through the base to the tripod or because they did not give a firm enough foundation to the camera. Finally, after much experimentation, an aluminum plate the size of

the entire base of the blimp was laid directly upon its felt floor. The area was large enough to prevent wobbling. To this plate were screwed alternate layers of balsa wood and sponge rubber, over which was laid another aluminum plate. Top and bottom plates were fastened to the rest of the assembly with strips of live rubber. The camera screw in the top plate is identical with that which holds the camera to the regular Mitchell tripod, and the camera has a trip which throws the motor out at the slightest film buckle.

A simple device enables the cameraman to follow the action of the scene before the camera. An adjusting ring clamps around the lens in use. A rod leading from this ring and fastened to another rod which extends through the bottom of the blimp enables the assistant to make any desired change in lens setting. A small lamp inside the blimp and a small window in the side door enables him to watch the graduations on the lens barrel during a change in lens setting. This arrangement has advantage in that he watches the actual scale, not a secondary scale mounted outside the blimp. Another rod extending from the camera allows a lateral movement of the finder which enables the cameraman to keep the subject always in frame.

This is an important point, especially if artistic effect is to be achieved. At the present time nearly all motion pictures are released in both sound and silent versions, in order to satisfy the need for pictures in those houses not yet wired for sound. The old silent motion picture film consisted of a series of pictures which measured approximately ¾ x 1 in. The present-day sound picture (sound-on-film, known as the Movietone Print), has lost approximately 1/10 in. of its lateral dimension, in order to accommodate the sound track at the side. Thus, it becomes necessary for the cameraman to compose his picture in such a way that the essential action takes place in the right nine-tenths of the scene. Then it is possible to block off the left one-tenth in the silent print.

Camera and blimp together weigh close to 260 lb., necessitating the development of a support for the assembly. The rolling tripod and tilt head which has been developed gives the cameraman nearly all the latitude with the heavy assembly which he formerly had with the lighter one. The tripod rolls upon rubber casters which may be left free or be locked into any desired line, thus removing the need for camera "dollies" or rolling platforms. Large levelling screws enable the assembly to be lifted off the casters if a more secure foundation is desired. The camera head is mounted upon a telescoping tube system controlled by a large handwheel. Supplementary supporting bars add rigidity. The blimp is mounted upon a flat surface supported upon rails which are sectors of a circle. The radius of this circle coincides with the center of gravity of the camera head assembly, insuring perfect equilibrium at all

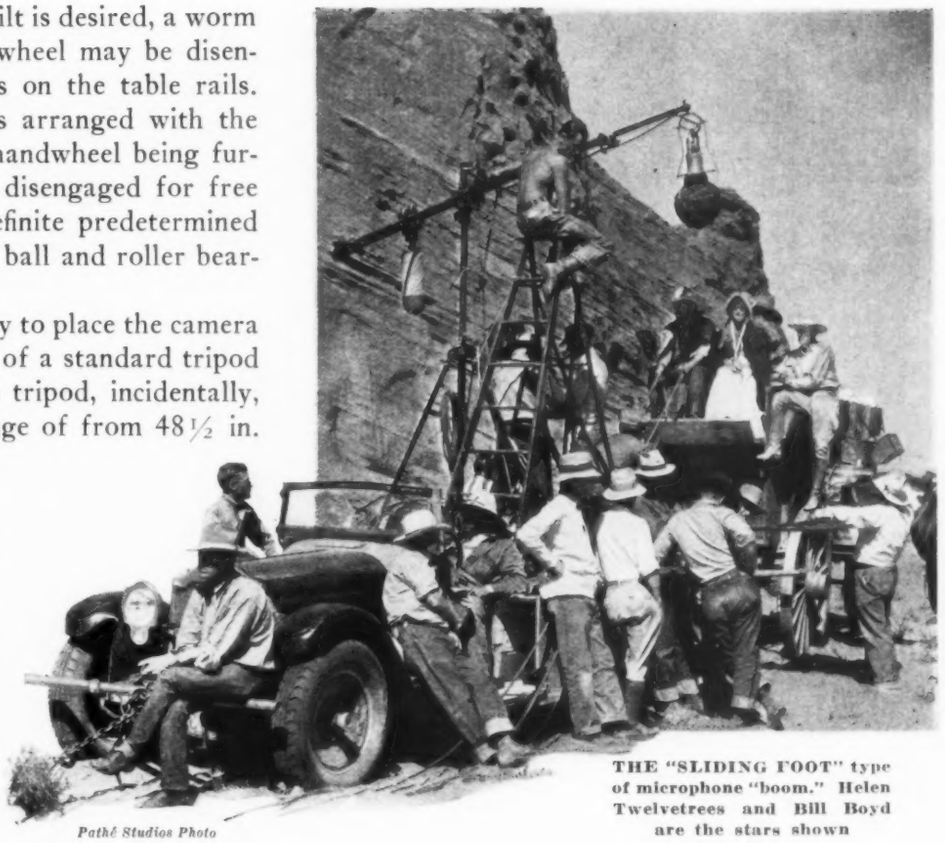


THE MICROPHONE "BOOM," which moves a "mike" easily over a large area. Dr. Lee de Forest, inventor of the audion tube used, with Metro-Goldwyn-Mayer engineers

MOLE - RICHARDSON rolling camera tripod of the low type, dubbed in the industry a "high hat"

positions of tilt. When free tilt is desired, a worm reduction gear and its handwheel may be disengaged from the gear sectors on the table rails. The "panning" movement is arranged with the same sort of mechanism, a handwheel being furnished which may either be disengaged for free motion or engaged for a definite predetermined slow motion. Liberal use of ball and roller bearings has minimized friction.

In some cases it is necessary to place the camera at such a height that the use of a standard tripod is out of the question. This tripod, incidentally, may be made to cover a range of from 48½ in. low position to 70½ in. high. An auxiliary tripod has been designed which allows the camera to be lowered to within 37½ in. of the floor. If a still lower operating position is desired, a sectional "high hat" or low platform, may be used, with which the camera may be lowered in steps of 1 in. to within 20 in., lens height, of the floor.



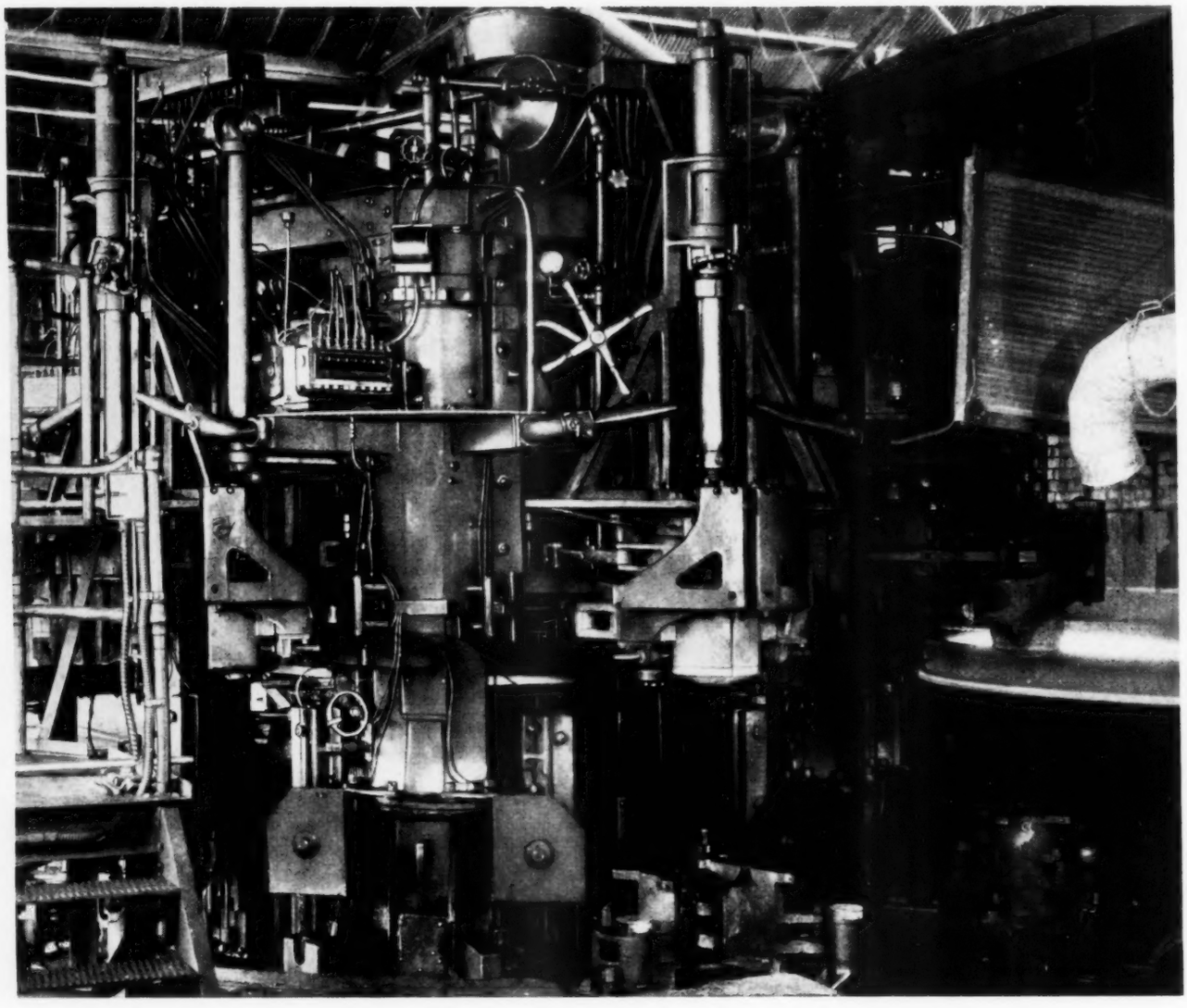
Pathé Studios Photo

THE "SLIDING FOOT" type of microphone "boom." Helen Twelvetrees and Bill Boyd are the stars shown

The first sound pictures shot in Hollywood were taken on small sets, and attention concentrated upon the many details of actual recording which presented themselves. "Canaries" (high frequency noises) and "sing" gave endless trouble. The microphone was concealed wherever it would be out of the range of the camera, yet pick up the required sound. As the art of sound recording advanced, however, and sets became larger, the question of microphone placement became of prime importance. With added flexibility of camera and microphone, it became necessary to follow the action with the camera. This was made possible by the development of the rolling tripod and camera blimp and the microphone boom. Early attempts at following the camera with the microphone consisted of hanging the "mike" on the end of a long pole, the assembly being moved about the set as the action demanded by an assistant stationed above. Appropriately, this was called "fishing." Another school of sound technicians attempted to achieve the same effect by the use of plurality of microphones placed at strategic positions about the set and fading from one microphone to another by the use of mixing panel. This fading from one microphone to another gave rise to "mike stew" and consequent errors in recording which would never be allowed to leave the studio today, but were passed at that time because of necessity. It has become, at this time, almost universal belief among sound recording experts that the most realistic effect may be obtained by keeping the microphone at all times in a certain definite relation to the camera. This, obviously, necessitates moving the microphone about the set to follow the camera on moving shots.

While the problem of designing a support for the microphone seems at first glance to be extremely simple, when proper consideration has been given to all factors, many angles enter the problem which at first glance might be easily overlooked. The prime requisite, of course, is that the boom be absolutely noiseless in operation. Many designs and devices were tried out, extensive work having been carried on at the Metro-Goldwyn-Mayer Studios in Culver City, Calif. The boom, as developed there, has a substantial three-legged base. These legs were mounted upon rubber-tired casters supporting a vertical column which in turn supported a lever arm with an adjustable portion which could be extended or retracted at will by winding in or out upon a crank attached to a cable drum. The weight of the microphone and arm is compensated for by a fixed counterweight. The boom is operated about a vertical and transverse base by means of arms. The sliding member

(CONTINUED ON PAGE 124)



ONE GIANT SUPPLIES AN INDUSTRY

$250,000 was spent in development, design, and construction of the world's largest bottle-blowing machine. Having more than 8,800 separate parts, it is 20 ft. in diameter, 20 ft. high, weighs 240,000 lb., and can produce 5,000 12-gal. carboys, or 8,500 5-gal. carboys, a day

By GARLAND LUFKIN

Chief Engineer, Owens-Illinois Glass Company

DEVELOPMENT and design attain unusual significance when their cost must be concentrated on one unit. Worthy of more than passing mention, therefore, is the world's largest bottle-making machine, at the Alton plant of the Owens-Illinois Glass Company, in all probability the only one of its type for some time to come, since it is capable of supplying the entire domestic demand. The economics of the situation presented an unusual problem in design. No "improved models," based on the correction of faults in the original mechanism, could be contemplated. The design adopted for construction had to be right, necessitating careful preliminary study and thorough checking of the final design.

The properties of the material to be worked affected design materially. Glass is a homogenous, non-crystalline solution of basic oxides, usually of sodium and calcium with silica. In its molten or plastic state, it is a sensitive substance to handle. It has no definite melting or solidifying temperature, but possesses the characteristic of extremely rapid increase in stiffness with only a few degrees temperature drop on cooling from a fluid state. In other words, it has a steep viscosity-temperature curve. In as much as the operations to be handled in the machine extend over a glass temperature range from approximately 2,000 down to 1,200 deg. F., one can appreciate the importance of close control of the successive steps, and the greater sensitivity involved as the size, and weight, of the bottle are increased. It is evident that the successful production of a blown-glass article requires, above all else, a definite temperature cycle, maintenance of which is the more difficult the larger the volume of heat to be liberated. A second important consideration is the incorporation of safety features to

"No Improved Models"

Design for costly single units must be right

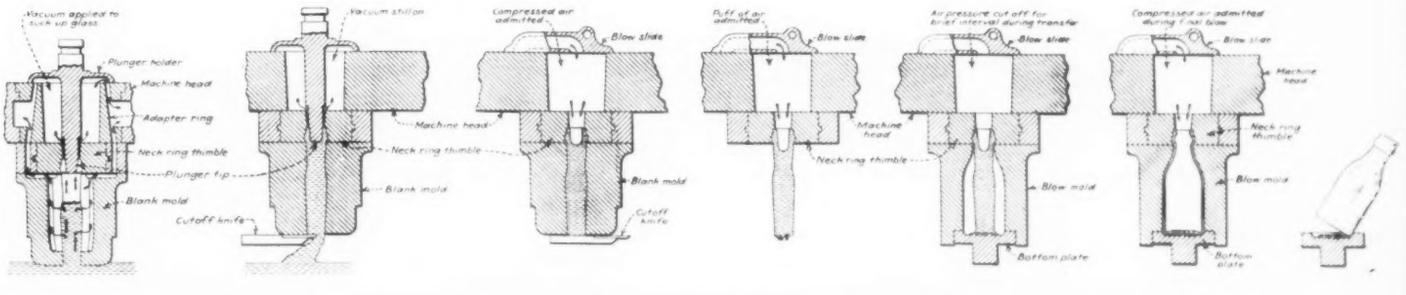
prevent costly breakdowns through jamming of parts if glass should "hang up" in the molds.

Few special materials were used in construction, simply because they were not economically justified. For example, weight is of little consequence where speeds are low, power input small, and rigidity important. Therefore, little use was made of light-weight alloys. A high-test cast iron with a dense, uniform structure was found most satisfactory for blank and finishing molds. It was also used for neck molds and plungers, unless the type of bottle to be made dictated the need of a special material with a higher or lower heat conductivity. The corrosive effect of hot glass on mold materials is severe, consequently a high-grade mold material is important. High-quality cast iron seems best to combine the requirements of correct thermal conductivity, resistance to rapid wear, freedom from changes in physical properties despite frequent reheating at the working temperature, ease of machining, and low cost.

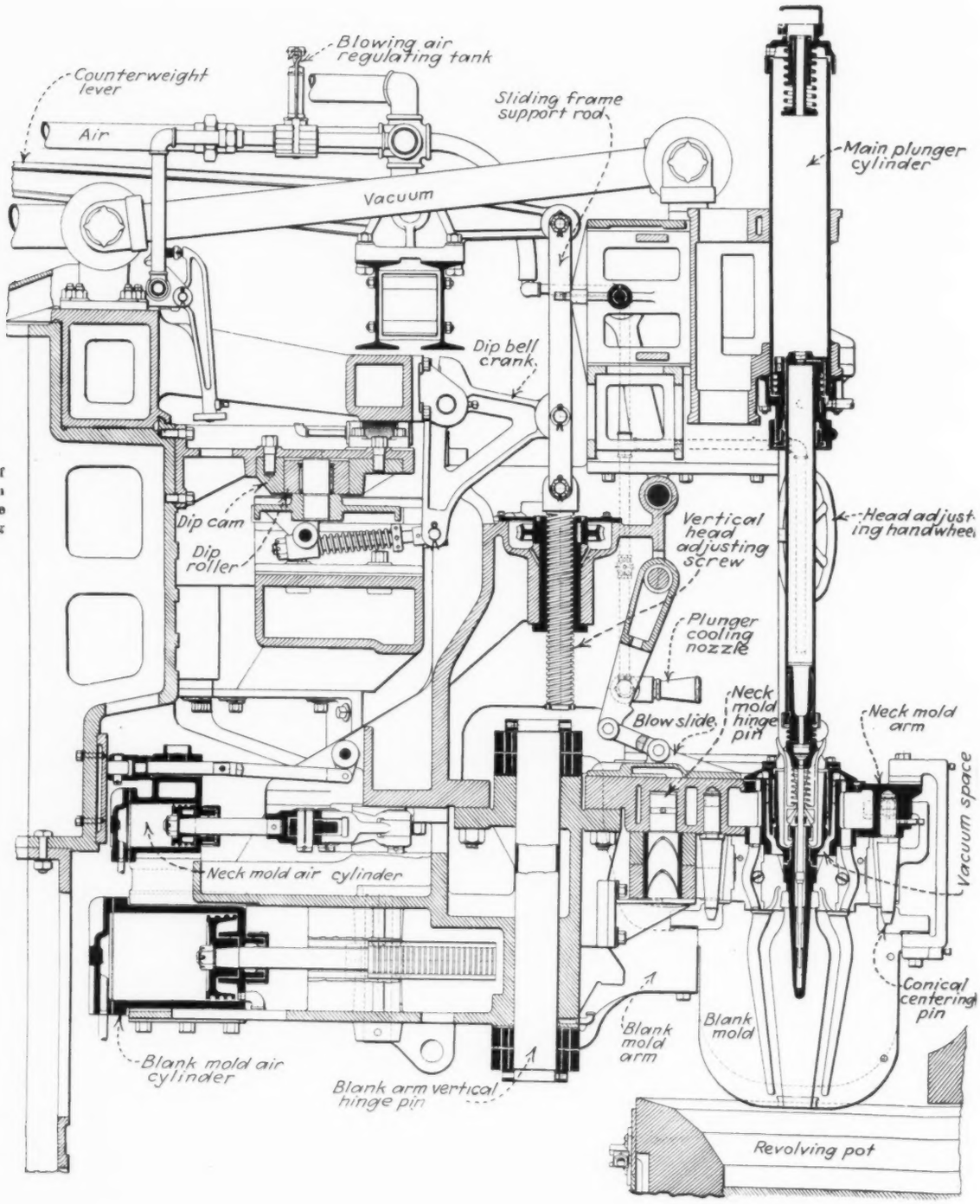
THE design of the machine must provide means to control accurately each step in the process. For example, a defect such as light shoulders and heavy bottoms in the bottles would be exaggerated if the machine did not incorporate means for temperature control of the blank molds to prevent over-cooling at the top and undercooling at the bottom, sensitive speed adjustment to give the glass within the blank mold the required amount of cooling time; a method for withdrawing the plunger from the "bubble" (neck depression) after it has imparted sufficient chill to the "finish" (bottle neck) to enable it to support the weight of the "parison" (shape of molten glass); an adjustable mechanism for opening the blank molds away from the parison as soon as the proper "enamel" (or partially chilled and viscous outer jacket) has been acquired by the latter; and other adjustable devices for closing the finishing mold around the parison, so that it can be blown out to final form at the correct stage of the cycle. A change in any one of these operations affects all the others, usually requiring a multiplicity of readjustments. A different combination of settings is required for each type of bottle produced. Provision, of course, must be incorporated for taking care of any of the vast number of defects that may occur in routine production.

The molding equipment, comprising six complete, individual bottle-making units, is mounted on a heavy cylindrical frame casting which rotates about a vertical stationary column. This column is attached to the machine base, which also carries a large circular horizontal bearing of tapered hardened rollers upon which the frame casting travels. A 2-hp., d.c. variable-speed motor drives the frame through a gear train and vertical pinion, journaled in the base, which meshes with a 5-ft. ring gear bolted to the lower end of the rotating frame around the upper half of the lower bearing. The entire machine may be withdrawn from the gathering basin on a two-rail track. Front and rear axles are provided, the latter equipped with manually-operated traction gearing.

In each set of mold equipment (beginning from the top of the column) is the plunger, neck mold, blank mold, cut-off knife, and blowing or finishing mold. The blowing mold and its allied mechanism constitutes the lower part of the head, while the remaining equipment comprises the upper head section. Upper and lower head sections are carried in separate vertical slideways, so that vertical motion can be imparted separately to each. Neck mold and blank mold arms pivot on vertical hinge pins in the sliding frame of the upper head section. In order to avoid excessive wear on the hinge pin and to assure accurate vertical alignment of the blank mold arms when supporting the heavy molds, each half of which weighs from 1,400 to 2,000 lb., the outer ends of the arms are provided with upwardly extending bearing flanges which overlap and slide on lubricated horizontal



CHARACTERISTIC operation of the automatic bottle-blowing machine includes seven major steps. In the first, the blank mold dips into the pot, and glass is sucked up to form the blank. The mold is then lifted and the excess glass cut off. In the third step, the plunger is withdrawn, the blow slide being moved into place and a puff of compressed air being admitted to solidify the blank. In the fourth step, the blank mold is opened and a further puff of air enlarges the neck opening. The bottom plate is then brought beneath the blank and the blow mold closed around it. The sixth step forms the bottle.



UPPER HALF of a half-section through one of the six bottle-blowing heads

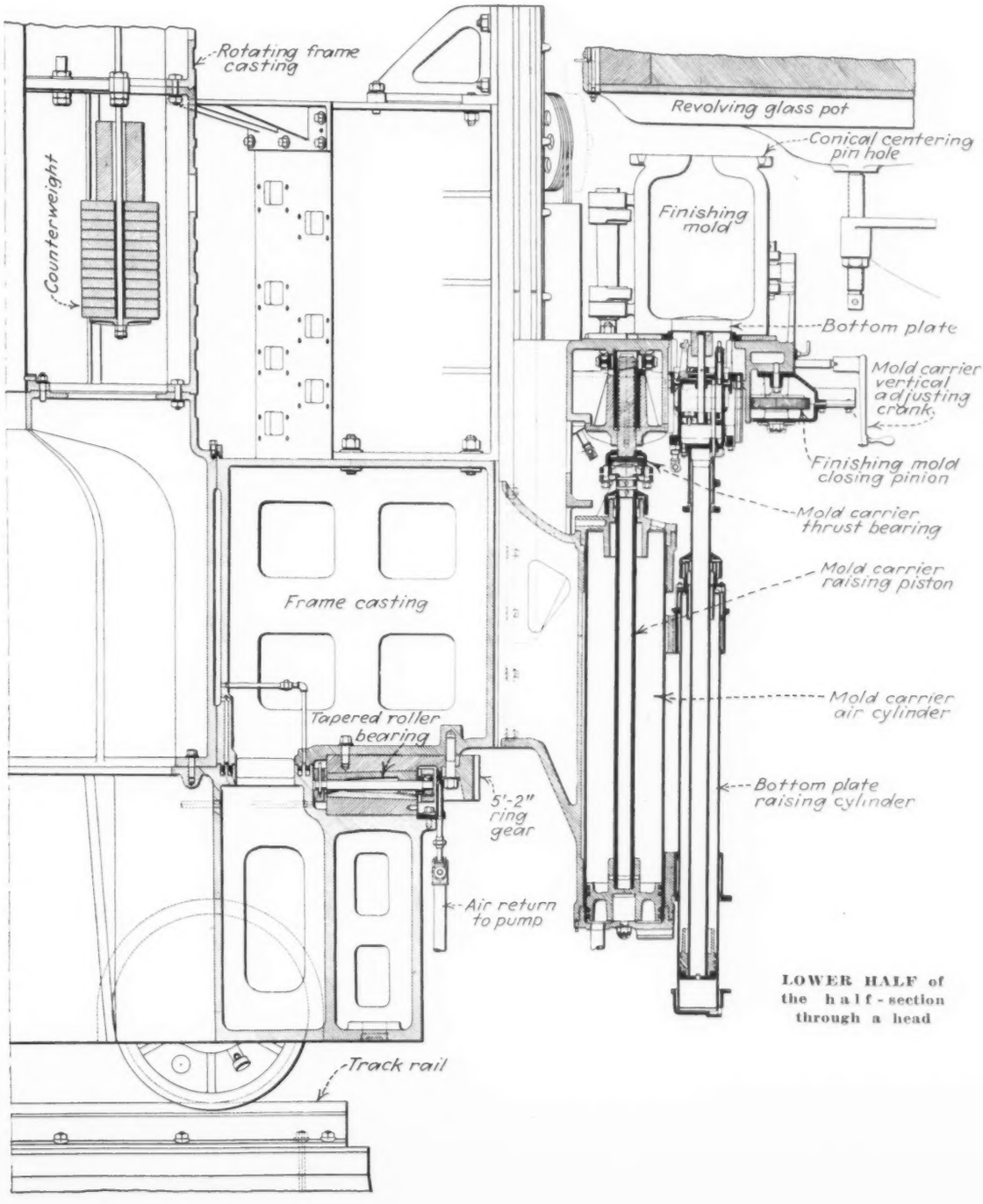
bearing plates radial with the hinge pin, thus giving the arms a two-point support. Each blank mold half is carried on its respective blank arm by means of three horizontal projecting lugs. These are uniformly spaced around the semi-circumference of the mold section, which rests on vertical adjusting screws in the arms. These screws are set to prevent leakages at the joints when the molds close by insuring accurate meeting of the vertical faces of the mold halves and tight contact of the recess in the top surfaces of the blank mold with the projecting shoulder of the neck molds. Neck molds are carried in pivoted arms directly above the blank molds. Both sets of molds are centered with respect to the center of the head frame and themselves by closing around locating pins which extend vertically downward from the head frame casting at the front and rear of the molds.

A PROBLEM in development was arrangement for rapid removal of parts for replacement or cleaning. For example, the adapter ring, a cylindrical piece pressed into the head frame casting concentric with the plunger, and bored out to allow the passage of the plunger through it, is provided with passages for the exhausting of the air from the blank mold cavity via the cored space around the adapter in the head frame casting. It is made a separate piece to permit its removal for carbon accumulations (which result from the lubricating oil burned off by the heat) from the interior vacuum passages, and also to simplify repairs necessitated by wear on the upper and lower surfaces.

Safety features are essential in the design of this type of machine. With the exception of the mechanism for lowering and raising the slide frame into and out of

dipping position for making a gather of glass, and the motor drive for rotating the machine, all movements are accomplished by means of air cylinders. Occasionally, in starting up the machine, a gather of glass may drop out of the mold and obstruct part of the mechanism. With a positive mechanical movement, this might cause breakage of a vital part, but with air pistons providing the motive power, the mechanism merely comes to rest when an obstruction occurs. The dipping, however, which imparts a vertical motion of 2 in. to the upper sliding head frame, was designed for cam operation, because there is little risk of mechanical breakdown and because a much shorter movement is involved than on the other parts. The only chance for interference with this dipping motion is in the event that the nose of the blank molds strike the edge of the "revolving pot." Should interference occur, the revolving pot is designed to tip on its supporting spider before sufficient force can be exerted to break anything. Cam working sections are cast and machined in radial sections bolted to the central stationary column, and are equipped with hardened liners of non-shrink, high-speed steel. This material is employed to provide minimum warpage during heat-treating, thus obviating the necessity for an elaborate machine tool set-up after hardening. Cam rollers are made of chrome-nickel steel, hardened and ground.

The pot itself is a basin 13 ft. in diameter with a glass depth of 8 in., having the rear portion inclosed in a refractory housing. The pot is supported on a cast-iron spider, and an adjustable d.c. motor drives the vertical shaft. The pot is rotated slowly, in order to prevent excessive and non-uniform cooling of the glass in the



LOWER HALF of the half-section through a head

dipping zone, and to bring the colder "tails" of glass, formed during the cut-off operation, back into the refractory housing, for reheating to gathering temperature. Glass is supplied to the pot through a trough overhanging the edge opposite the machine, and connected to the melting furnace. An adjustable refractory stopper is inserted in the trough to control the rate of flow of the fluid glass so that the pot is maintained level full at all times. To minimize wear, power consumption, and strain, and to give as smooth a dipping action as possible, each sliding upper head section is counterweighted through a system of levers and linkages which consist of an upward extension to the vertical link between the supporting screw and the bell crank, a horizontal lever with its outer end attached to this extension and its inner end supporting a vertical rod, extending downward through the central stationary column, which carries the counterweights. The horizontal lever is fulcrummed in a block mounted on a circular I-beam spider which rotates with the machine, and which has a diameter such that a 3 to 1 lever arm ratio is obtained, that is, the counterweights are but one-third as heavy as the sliding frame.

ACCOMMODATION for various sizes of bottles is incorporated. Thus, the bushing in the sliding frame, which engages the supporting screw, is arranged for rotation through a worm gear attached to its upper end driven by a worm wheel, the shaft of which extends outwardly and carries a handwheel accessible to the machine operator. By this means each head has an individual vertical adjustment of $6\frac{1}{2}$ in. for different lengths of blank molds and uniform immersion of molds in the molten glass. Thus, various sizes of bottles may be run simultaneously on separate molding sets.

Most sections of the various air-cylinder operating cams are made in short lengths, easily removable, so that each valve can be opened at any desired point on the cam circle. Seven of these cam circles are arranged one above the other around the central stationary column of the machine. Cam circles with adjustable segments are also provided around the upper part of the central column to operate the individual lever valves on each head which admit vacuum and blowing air to the mold equipment.

Since the design of the machine requires that all elements rotate around a central column, it is necessary to introduce all external factors through this column. For example, approximately 15,000 cu.ft. of air per minute cools the mold equipment. Air is supplied at 45 lb. to operate the air motors, while the cooling air is supplied at 8 lb. through a regulating valve in the rotating distributor ring. Both compressed air and vacuum are admitted to the main supply line on each head of the machine through a circular distributor attached to the top of the column. The inner stationary shell of the distributor is divided vertically into separate compartments, one for compressed air, the other for the vacuum line. Surrounding each of these compartments is a cored ring attached to the rotating frame of the machine and held in vertical alignment on the stationary head by circular guides which have beveled-edge flanges that fit into packing recesses on the cored distributor rings, so that leakage of air is prevented. Each head has individual connections for air and vacuum on the distributor ring. Swivel joints and telescoping piping in the vacuum line, and flexible hose connections in the air piping allow vertical motion of the head without leakage.

IN MANY cases, it was necessary to design a motion to fit the space. The opening and closing motion is transmitted to the blank mold arms from the air-operating piston by means of a rack on the end of the piston rod which has teeth cut on opposite faces in a vertical direction. These teeth engage with gear sectors on the rear ends of levers, the front ends of which are attached to lugs on the blank mold arms. The motion is multiplied through the sector gears and lever arms to open the blank mold halves wide enough for clearance with the finishing mold when the latter rises to encompass the parison. The amount of opening required for the neck molds is relatively small, consequently the movement is obtained through a simple cross-head and slide construction. Another instance where long travel is gained with a short piston travel is that of the cut-off knife rack. This rack is actuated by a piston mounted on the vertical shaft carried in the guide assembly. A second pinion is also keyed to this shaft, and is engaged by a rack attached to the end of an air-cylinder piston rod located within the rotating column. The cut-off knife is a flat plate of high-speed steel with an outer cutting edge, held horizontally on the forward end of the knife rack.

Naturally, the lubrication of a large and costly machine, operating under severe temperature conditions, is a highly important factor in design. A reservoir-fed mechanical force-feed lubricator lubricates the main roller bearing. Motor drive shaft bearings are lubricated by individual wick-feed oilers. Air cylinders and air valves are supplied with oil through mechanical force-feed lubricators. One lubricator is mounted on each head and is driven by an electric motor through reducing gears.

In addition, there are approximately 24 points on each head, and approximately 12 miscellaneous points per head, such as guides, to be lubricated. In order to take care of these 36 points in each section, a 24-feed wick-feed oiler and a 12-feed wick-feed oiler are mounted above each head. Oil is led from these oilers to the points requiring lubrication through annealed flexible copper tubing. Hand oiling is entirely eliminated in the design of the machine.

Bottle blowing is conceded to be a difficult operation to conquer mechanically. When large bottles are to be blown, the difficulties are multiplied, difficulties which had to be anticipated before the machine could be built. Some important possible bottle faults are "checked" or cracked, incompletely filled or inaccurately sized "finishes" or bottle necks; large seams on bottle necks or bodies; crooked bottle necks or misshapen bodies; light sides, "slugged" or non-uniform distribution of bottom glass; or checked or light bottoms. An enumeration of the means to overcome these troubles would be much too lengthy; perhaps the few examples previously given suffice to show the various ways adopted to overcome them. Only in this way could we possibly hope to make large bottles mechanically, and only in this way have we been able to justify the expenditure of a quarter of a million dollars for a single unit, a unit that had to work properly.

✦ ✦ ✦

When aluminum is chosen as the base metal, attractive color combinations can be secured that are wear resistant and permanent

Colors in Aluminum
by Plating, Dyeing, Oxidizing

By JUNIUS D. EDWARDS

Assistant Director of Research, Aluminum Company of America

WITH the advent of modernistic ideas in product decoration and design, the use of aluminum for purely decorative purposes has increased because of the striking contrast given by the aluminum color when used with black or with the strong primary colors. In most cases, however, aluminum is used because of its desirable physical or chemical characteristics. Even in these cases color may be desired as part of a decorative scheme.

Where a different metallic effect or color is desired, it is entirely feasible to electroplate aluminum with other metals. Although only a few years ago the electroplating of aluminum was imperfectly understood, the relatively recent development of practical and efficient plating methods has led to widespread use. It is possible to plate aluminum with nickel, chromium, gold, silver, copper, zinc, or brass. By plating, it is possible to duplicate on aluminum almost any metallic finish possible on other metals. An example of the practical application of plating methods is furnished by the chromium-plated aluminum hub cap. Cost and the easy forming characteristics of aluminum alloys made their use for hub caps a very attractive possibility, but the prevailing use of chromium finish on automobile hardware required chromium-plated hub caps. Plating with nickel and

then chromium proved entirely practical and the plated hub caps gave excellent service. There are now more than five million of these hub caps in service. Where a lacquer or enamel finish is desired on aluminum, it can be applied with little change in the characteristics of the lacquer or enamel used on other metals.

The compounds of aluminum are practically all colorless, so that coloring methods applicable to copper and its alloys, for example, do not work with aluminum. This is an important advantage in one respect, since aluminum can be used for exterior decorative and architectural work without staining stone and other structural materials with which traces of corrosion products may come in contact. Aluminum readily forms on its surface a coat of oxide which is very effective in protecting the metal against corrosion. By special means, oxide coatings can be formed on aluminum. These oxides are particularly useful in coloring the metal. Aluminum oxide itself is white, but commercial aluminum contains a fraction of a per cent of impurities such as iron, silicon, and copper, so that when an oxide coating is formed on aluminum by chemical means, the presence of these impurities may color the oxide coating gray to black, with various shades of brown as possibilities, depending upon the method used. A practical application of this method has been made in connection with aluminum shingles. The bright aluminum finish of the uncoated metal does not harmonize with most architectural designs. However, by treating the aluminum shingles in a hot dilute solution of chemical salts, carefully controlled as to composition, the aluminum shingle can be given a gray, enamel-like coating that is attractive in appearance, and not far different in color from a light slate-gray.

Oxide coatings can be applied to aluminum not only by chemical but also by electrochemical means. If aluminum is made the anode, that is, connected to the positive terminal in an electric circuit, and immersed in a suitable solution, an oxide coating is formed on the surface of the aluminum. Such an oxide coating is formed when a wide variety of weak acids or salts are used in the solution, but when special characteristics are desired certain solutions have been found to work best. For example, by anodically oxidizing aluminum in chromic acid, an oxide coating of high corrosion-resistant properties is produced. An oxide coating of this kind makes a superior foundation for protective paints, and is widely used for finishing aircraft parts made of the duralumin-type alloys.

Another kind of oxide coating on aluminum has very pronounced adsorptive qualities, and shows a strong affinity for certain types of organic dyes. Oxide coatings of this type have been made the basis of coloring processes which are now being used commercially. In carrying out this process, the aluminum article after being electrolytically oxidized, is immersed in a hot solution of the dye and it immediately begins to adsorb the dye color from the solution. The operation is very similar to the dyeing of textiles, and an almost infinite variety of colors can be secured. The idea of dyeing aluminum metal is unique but quite understandable, since compounds of aluminum are used as mordants in the dyeing

ON MANY VARIETIES of low-priced products where appearance is a selling factor aluminum can be used as the base and colored with oxides or dyes

of textiles, and it is on these oxide compounds that the dyeing is accomplished.

It is true that by the use of paints, enamels, and lacquers, a wide variety of colored effects can also be secured on aluminum, but the dyed oxide finishes are characteristically different in several important particulars. From the standpoint of color itself, the effect is decidedly pleasing. The dyed oxide finishes may be produced with a luster and a depth of color which are highly attractive, and they combine the color of the dye with the metallic luster of the uncoated metal. In the second place, the oxide coating is hard and abrasion-resistant, so that the colored coating gives satisfactory service where wear-resistance is a factor. The coating in respect to hardness resembles corundum, which is crystallized alumina. The abrasion resistance is dependent on the thickness of the oxide layer, and in one test an oxide coating about 0.0004 in. in thickness showed an abrasion resistance some 5 to 10 times as great as 5 coats of baked enamel. Furthermore, the oxide coating is formed from the metal itself and is very adherent. If it is thick it may show some cracking on bending, but it will not flake from the metal. Thin coatings, however, about 0.0002 in. in thickness, give satisfactory wear-resistance and are sufficiently flexible not to crack with ordinary bending of the sheet. The texture and luster of the dyed oxide finishes can be changed at will. If a smooth, enamel-like surface is desired, the aluminum can be given a high polish before oxidizing. If a dull matte surface is desired, the metal can be roughened by etching or sand-blasted before oxide coating and dyeing. The oxide finishes can also be waxed or lacquered.

BOTTLE CAPS and machinery nameplates of aluminum are being made in many colors by this method

Sufficient experience has not yet been gained to determine the ultimate serviceability of dyed oxide coatings when exposed to the weather. All organic dyes are susceptible to fading in some degree, although a number of them, when applied to aluminum, are surprisingly resistant to fading, and may have use outdoors. Indoors, however, the more stable dyes are quite permanent. For outdoor service another type of oxide coating is being developed, which is colored by mineral colors adsorbed by the oxide, and some of these may prove sufficiently durable for outdoor service.

If certain of the alloys of aluminum, as for example, the aluminum-silicon alloys which are so much used in architectural and casting work, are electrolytically oxidized, the alloying constituent may have a decided coloring effect. An alloy containing 5 per cent silicon takes a light gray to black coating when electrolytically oxidized. Finishes of this character have been extensively used on spandrels and other architectural castings of aluminum alloys. The new Empire State building in New York City carries over 5,000 aluminum alloy spandrels colored with a gray oxide coating. The gray oxide coat can also be used in conjunction with highly polished areas of the alloy to give pleasing color effects.

With so many processes available for coloring aluminum, a wide variety of requirements can be met as to color, texture, luster, hardness, protective qualities and the like. Aluminum and its alloys will show the same versatility in the field of color that they have in mechanical fields where light weight and strength are important qualifications.

There has been a definite need for a material capable of taking color in a variety of ways and with a variety of finishes, yet capable of withstanding corrosion and having proper hardness. With its properties, aluminum bids fair to offer many possibilities.

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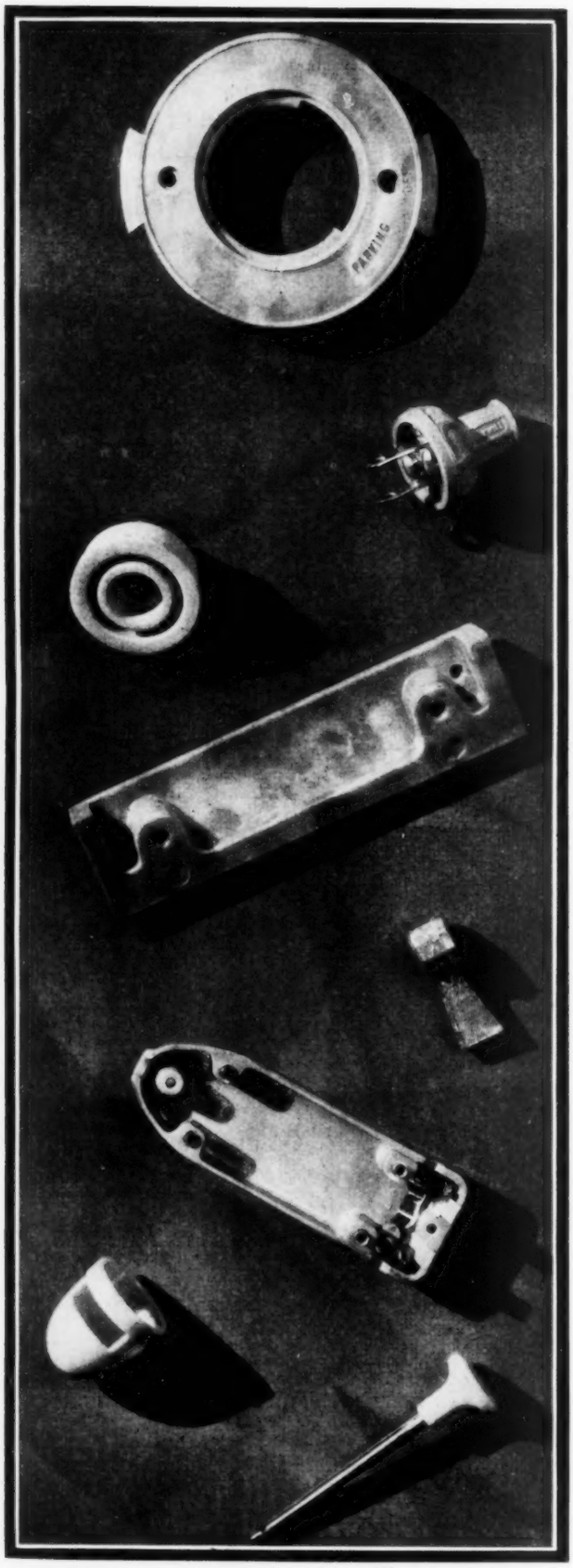


DASH-BOARD controls, horn buttons, electric fixtures, drawer pulls, and handles are some of the things molded from urea plastics

Illustrations from Aldur Corporation and Synthetic Plastics, Inc.

UREA RESINOIDS

as molding materials

By RICHARD KOCH

Assistant Editor, Chemical and Metallurgical Engineering

THE GROWING popularity of plastics for quantity fabrication of both decorative and utilitarian objects has been shared by two groups, as primarily distinguished in the fabricator's mind; the thermoplastic type such as Celluloid or Pyralin, which can be reworked under heat, and the thermo-setting type, such as Durez and Bakelite, which react in the mold to produce a permanent and infusible chemical product. A material of the thermoplastic type was described on page 72 of the February number of *Product Engineering,* while thermo-setting materials were described on page 227 of the May, 1930, number. While most of the latter group are made from a base of carbolic acid, a newer product has forged its way to recognition by virtue of the properties imparted by a urea base.

In this country examples of this newer type are "Beetle" and "Aldur," while in Germany "Pollopas" and in England "Beatl" have been available for some time. Other molding materials of this group are also being placed on the market. The reason why the technical research facilities of these companies devoted so many years to perfecting this material commercially was primarily its infusibility after molding and its clear transparency—which means unlimited possibilities of coloration. The main obstacle to a successful

product was the tendency of a pure urea resinoid to develop cracks under normal conditions and, though the exact reason has not been ascertained, the modifications now employed in manufacture have resulted in a more stable product.

Ready coloration of urea plastics and lack of odor at normal temperatures have been their leading advantages over the phenolic types, since they contain no chemicals that act to fade or affect the hue. While none is sold in waterwhite condition, the addition of dyes and pigments still leaves a brilliant translucency that has helped to popularize the various domestic objects, such as cups and plates, widely displayed in department stores.

THE manufacturers, in so far as they do not fabricate the materials, sell them as mixed powders in several colors ready to mold. The molding technique is similar to that applied to phenolic resins, but the delicate shades require meticulous control against dirt and dust. Molding temperatures vary between 275 and 330 deg. F. depending upon the character of the work, and the pressures required range between 2,000 and 5,000 lb. per sq.in., lower than in the earlier days. The compression ratio in molding the original powder to solid plastic is 2½-4 to 1, but may be smaller when the powder has been preformed. It may be repeated that the molding produces a final chemical product that is not subject to refabrication or "cold flow"; that is, the property of permanently deforming at normal temperature under stress.

In weight, the urea compounds do not differ greatly from the other plastics. The specific gravity ranges between 1.48 and 1.58, about twice as heavy as hardwood, but much lighter than metals or glass. A pound will usually occupy about 18 cu.in. The tensile strength has also been found in tests to fall within the limits of other plastics, ranging as it does up to 7,000 lb. per sq.in. The elasticity modulus, measured in pounds per sq.in., is 0.9-1.25 $\times$ 10^5 and the thermal expansion is 0.000045-0.000060 in. per in. per deg. C.: both again comparable to the phenolic resins. In terms of common usage, this means that the material is well able to withstand the strain of normal impacts and will vary only slightly in size with changes in temperature.

Urea plastics will not melt or burn on heating, but they begin to char and decompose when exposed to temperatures higher than 400 deg. F.; between 225 and 400 deg. F. some shrinkage occurs after long exposure. Under water and in very humid atmospheres they absorb a slight quantity of moisture at the surface—about 0.1 per cent after 24 hours of immersion of a normal test block in water at 68 deg. F. Water exerts no influence as a result of this minute absorption, and the same applies to solvents, alcohol, fats, and oils. Certain industrial reagents such as strong acids and alkalies do attack the material.

Sunlight and ultraviolet rays, which are becoming increasingly respected as chemical reagents, are transmitted by urea plastics and not filtered as by normal glass. This has led to some experiment on their use for transparent window panes, not yet successful. This advantageous property, however, plays a decisive part in the choice of coloring matter, for it requires an absolutely light-fast pigment or dye to resist the full force of rays pouring through the urea resin itself.

Some of the successful applications of this group of molding materials include cosmetic boxes and jars, meter cases, clock cases, automotive specialties, electrical parts, and various novelties. It is possible to incorporate metallic inserts in molding, although the fact that the material is primarily adapted to thin sections still limits their use.

Nevertheless, such difficult articles as telephone hand sets have been molded successfully with inserts without displaying serious trouble from expansion and contraction. Future applications of these materials will depend largely upon the ability of the designer to apply them to suitable parts where their particular properties can be used to advantage. No one material is a "cure all" for all applications, and molding materials, with their ever-growing varieties, have reached the same status as alloys where the engineer must choose the one to fit the occasion.

Translucent color effects and hardness bring the urea molding materials forward for many mechanical parts. Transmission of ultraviolet rays also opens possibilities as an "organic glass" for molded parts

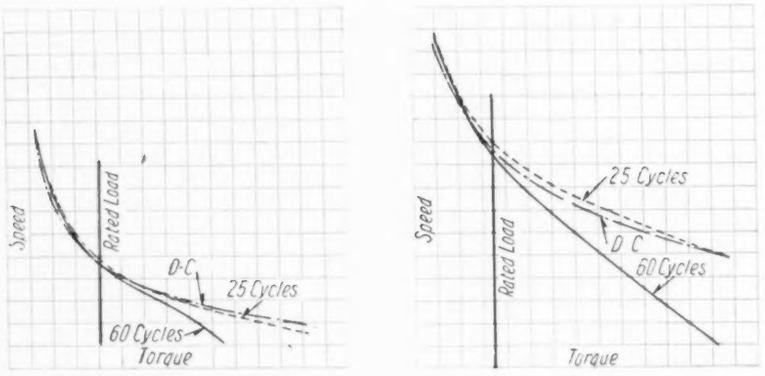


FIG. 1

COMPARISON of speed-torque curves, right, a universal motor with salient pole windings,—left, distributed compensated windings

Universal, C

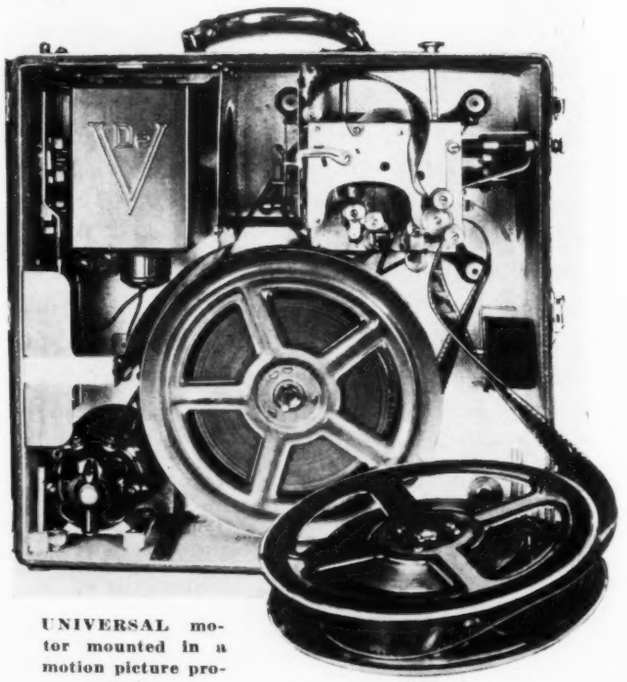
UNIVERSAL motors are series-wound and can be operated either upon direct current or alternating single-phase current, at approximately the same speed and output. The standards of the National Electrical Manufacturers' Association specify that these conditions must be met when the alternating and direct current voltages are about the same, and the alternating current frequency is not greater than 60 cycles per second.

Universal motors have several limitations, however. It is impossible to get the same operating characteristics on a.c. and d.c. lines. To meet certain conditions, distributed stator windings are used in place of the usual concentrated pole windings of the ordinary d.c. motor. This compensates for field distortion. Some applications may require the improved universal characteristics obtained in the compensated series wound motor, despite its slightly higher cost as compared to the ordinary universal motor.

As in all series motors, the speed of the universal motor decreases as the load increases. At no load the speed may become excessively high, the average no-load speed of these motors being in the neighborhood of 15,000 r.p.m. Full load speeds commonly range between 4,000 and 10,000 r.p.m. for different applications.

Fans, blowers, hand-tools, portable saws, home motion-picture projectors, and devices wherein the motor is at all times under sufficient load to prevent excessive speed, use universal-type motors. For speed control, as in motion-picture projectors, adjustable rheostats are used. Universal motors cannot be employed if the speed must be maintained constant at varying loads. Hand manipulation of a rheostat may serve to maintain approximately constant speed, provided the load variations are not too great and too frequent. Incidentally, if a rheostat is incorporated in the device, rheostat and ventilating capacity must be such that the heat loss is dissipated.

Many universal motors are sold by the motor manufacturers as sets of parts consisting of wound stators, rotors and commutators mounted on the shaft, and brush-holders. The housing and bearings are supplied by the manufacturer of the device. This arrangement is sometimes a source of trouble. Best results can be obtained only when there is close co-operation between the product designer and the motor manufacturer. One instance is known wherein, to facilitate assembly, a clearance of $\frac{1}{64}$ in. was permitted between the primary coil and the bore of the housing. This, of course, decreased the magnetic flux density and the motor did not work satisfactorily.



UNIVERSAL motor mounted in a motion picture projector

FIG. 2

l, Capacitor, and High-Frequency MOTORS

Third of a series of articles on electric motor applications

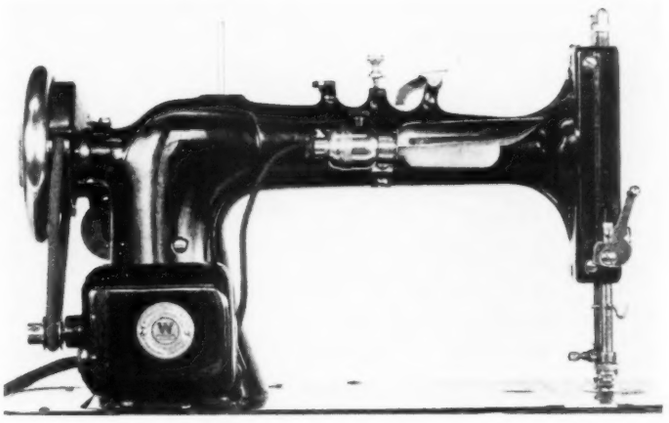


FIG. 3
UNIVERSAL motor mounted on a home sewing machine

Provision of proper ventilation also is sometimes overlooked when the product engineer designs the motor housing. If the natural ventilation to the motor is poor, it should be equipped with a fan on the rotor in order to produce a forced circulation of air. Grease cups and oil cups should be placed so that they will be readily accessible, particularly in the design of household devices. Lubrication provisions should be such that frequent attention will not be required.

Before preparing motor specifications, the engineer must first determine the torque-speed characteristics required for the driven machine. Usually the starting and normal running torque can be determined only by careful tests under actual operating conditions. Allowances should then be made for incidental overloads, normal variations in line voltage, load differences resulting from manufacturing variations, wear, and lubrication of the machine. If possible, it is best to take advantage of the service offered by most motor manufacturers whereby they make the tests on the devices to determine the most suitable frame size and winding of motor.

Domestic appliances in continual operation such as refrigerators and oil burners, requiring fractional horsepower motors, demand a motor that will operate quietly and require a minimum of maintenance. Moreover, in starting, the current surge should be limited so that the lights in the house and neighboring houses will not dim. High power factor is another much desired characteristic.

Capacitor motors run very quietly and require a minimum of attention. Their power factor is high; starting current is low. In mechanical construction, they are similar to a polyphase motor having a wound stator and a squirrel-cage rotor. No commutator or brushes are required, making possible a short over-all length and unusually compact motor frame. For normal starting torque, one of the stator windings is connected to the line and the other to a static condenser. In order to procure extra high starting torque, an additional condenser or auto-transformer is interconnected to both the main and auxiliary windings. When the motor is approximately up to speed, a centrifugal switch mounted on the rotor disconnects the extra condenser or auto-transformer used in starting. Ordinarily, the condensers are mounted in a box separate from the motor but in some sizes the capacitor is furnished mounted on the motor.

One of the characteristics of capacitor motors is that the pull-up or accelerating torque is maintained, that is, there is no dip in the torque-speed curve as the motor comes up to speed. As the pull-up torque is equal to the maximum running torque, these motors will accelerate any load they

are capable of carrying. Their maximum output is such that the motor can handle heavy overloads without stalling.

By the use of a special controller box, and in conjunction with an auto-transformer to drop the voltage, or by special wiring to vary the number of poles, multi-speeds can be obtained. Thus, a two-speed controller makes it possible to operate the motor at full speed or half speed. A four-speed controller can be designed to give full speed or 80, 60 or 40 per cent of full speed. This speed control feature is very useful for application to multiple-speed fans or blowers, and similar devices.

In general, capacitor motors are higher in price than split-phase induction motors. Capacitor motors are in the same price range as repulsion-induction motors, but when the cost of the finished product is high the extra cost of a capacitor motor as compared to a split-phase motor is readily "absorbed." It may be expected that, when the other distinct advantages of the capacitor motor are sufficiently impressed upon the buyers this type of motor will be in much greater demand. Though capacitor motors are now coming rapidly to the front, there still seems to be a prejudice against them, perhaps because of their higher price and the lack of proper recognition of their desirable characteristics.

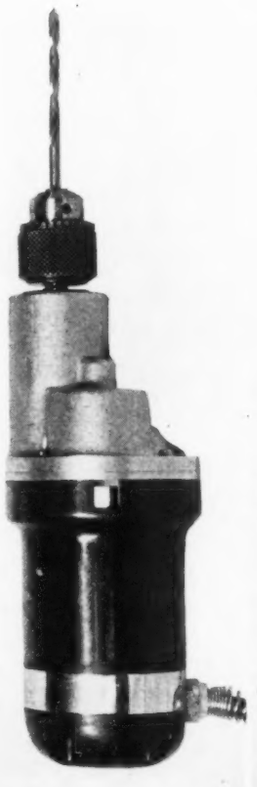
Capacitor motors are used today chiefly where single-phase motors may be objectionable. Prominent in the list of applications are such items as building equipment, such as fans and blowers, in which quietness and good variable speed characteristics are important. This type of motor is furnished also without shaft or bearings for use in grinders and in wood-working equipment, in which case commutator and brush assembly drawbacks are avoided. Where inertia loads are high or reversal is required some makers do not recommend capacitor motors.

DURING the last decade, the high-frequency motor has been gaining prominence. Such motors operate at speeds up to about 50,000 r.p.m. They are squirrel-cage induction type motors, hence have no brushes. Their high speed is attained by supplying them with high-frequency alternating current. The speed is directly proportional to the frequency of the current supplied and inversely proportional to the number of pairs of poles in the motor. Such motors can be operated on normal frequency lines at normal speed, from high-frequency generators or from frequency converters.

Etching machines, wood shapers, rayon spinning pots, internal grinders and similar types of high-speed machinery are driven by high-frequency induction type motors. High speed results in a light compact motor. For this reason, high-frequency motors are being generally adopted for portable motor driven tools such as drills, reamers and nut setters.

IN the case of rayon spinning, a cup or pot is mounted directly on the vertical shaft of the motor and rotated at 6,000 to 8,000 r.p.m. The cup is about 7 in. in diameter and is made of molded Bakelite or similar material. While the bowl is spinning, the thin fibers of rayon coming from gold or platinum spinnerets, usually with 24 holes of 0.001-in diameter, are fed vertically into the cup by gravity. The spinning of the cup serves to twist the fine fibers into a thread.

These rayon spinning motors must be acid-proof. The motors are enclosed in a heavy cast frame especially designed to protect the working part from the dripping acid, the frame being coated with an acid-resisting finish such as



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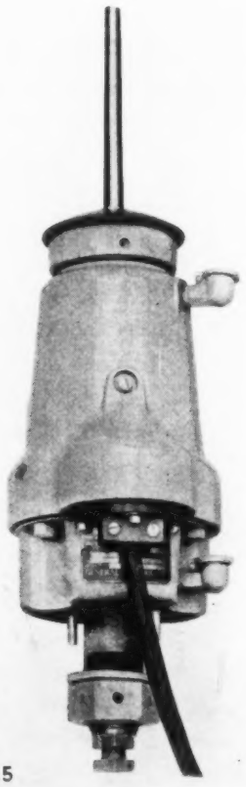

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COMPOSITION frame of this universal type drill motor makes a light tool that does not get too hot. Right: Induction rayon motor, 0.15 hp., 7,200 r.p.m., 94 volts, 120 cycles. All exposed parts are made corrosion resistant

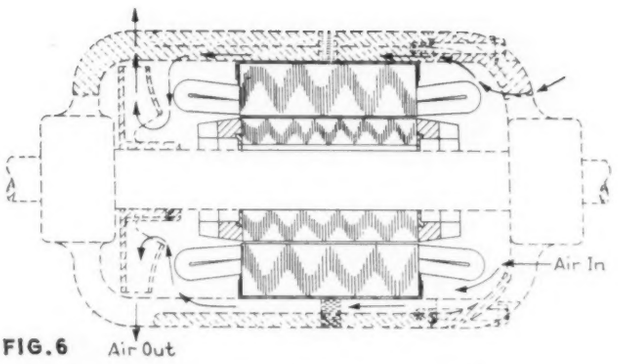


FIG. 6 MOUNTING and ventilating diagram for a high-speed built-in motor. Dotted lines indicate portions to be supplied by purchaser of the motor parts

Bakelite varnish. In the motor illustrated, a Bakelite deflector, or one of similar material, prevents acids from entering the top of the motor. The stator windings are also impregnated with acid-resisting varnish. The rotor winding is of cast construction and the complete rotor is mounted on a heat-treated alloy steel shaft. Radial loads are taken by ball bearings, one above and the other below the rotor. A special ball step bearing at the lower end of the shaft takes care of the downward thrust. Frequent lubrication is unnecessary as a large oil reservoir is provided. The oil is filtered as it flows slowly from the reservoir through a felt ring and into a small inner chamber. Oil vapor from the inner chamber is pumped directly to the radial ball bearings where it condenses above the bearings and the excess drains back into the reservoir. A resilient washer located between the bottom of the motor and the mounting rail damps the transmission of vibration from the rail to the motor and also provides a resilient mounting to absorb vibrations when the motor is passing through the critical speed.

SUCH high speeds of rotation require very accurate dynamic balance of rotating parts, including both driving and driven elements. Moreover, the critical speed of the rotating elements must be carefully calculated so that the operating speed will be well away from the critical speed. Otherwise serious vibrations will occur. In such applications as the rayon spinning pots described above, it is important that the product designer and the motor designer cooperate to see that the critical speed of the rotating element is properly calculated and this speed avoided.

Rotors and stators of high-frequency motors are sold as parts for built-in motors. They are made in sizes ranging from 0.3 to 30 hp. to operate at frequencies of 25 to 500 cycles, giving speeds from 1,500 to 47,000 r.p.m. Their design calls for a constant speed and an allowable temperature rise of 40 deg. C. under continuous duty. They are applied to woodworking, grinding, and other machines requiring practically constant high speed under all load conditions.

The limit of peripheral speed for all of these high-frequency motors is 14,000 ft. per min. They are wound in three distinct series: (1) Normal frequency series, the base of which is 220 volts, 60 cycles, with a range up to 440 volts at 120 cycles; (2) The first high-frequency series, the base of which is 220 volts, 120 cycles, with a range up to 366 volts, 199 cycles; (3) The second high-frequency series, the base of which is 110 volts, 500 cycles. These series, under certain conditions, may overlap each other. Outside diameters of these high-frequency, high-speed motors are reduced to lowest practical limits in order to minimize the centrifugal forces involved. The relatively small diameter of these motors also permits of close spacing of the shafts or spindles.

IN the design of the machine on which the motor is to be used, provisions must be made for ventilating air so that it may be drawn in at one end, then over the windings and out at the opposite end. Or the ventilating air may be drawn in at each end and forced out at the middle. In either case, the air intake should be at a point where no injurious material can reach the motor itself, and where falling material will not enter. Usually an auxiliary fan is located inside the housing and directly mounted upon the rotor shaft to produce a powerful draft of air, and provide effective ventilation to keep the motors cool. In addition, because of the high air velocity, it prevents clogging of air passages. The blast of air is usually sufficiently powerful so that there will be no need for blowing out the motors periodically. These features are of importance when the motors are to be applied to woodworking machinery where there is a constant accumulation of dust. For this reason also, the outside surface of the casing should be made smooth. The accompanying figure shows a mounting and ventilation scheme for built-in motors as recommended by one motor manufacturer. The dotted lines in the figure indicate the elements of the motor which are supplied by the purchaser.

Photographs from the General Electric Company, Westinghouse Electric & Manufacturing Company, and Bodine Electric Company

STRESSES

By CHARLES H. JENNINGS

Westinghouse Electric & Manufacturing Company
Applied Mechanics Division, Research Laboratories

WELDING as a method of fabricating large size machinery has necessitated the use of large fillet welds. In many cases these welds are subject to bending stresses rather than direct tensile stresses. It is of great importance, therefore, to know the strength of large fillet welds subject to transverse bending, and to know whether or not large welds are subject to correspondingly greater residual stresses. For this reason, an investigation was conducted on $\frac{3}{4}$-in., 1-in., and $1\frac{3}{8}$-in. fillet welds.

Twelve specimens were prepared, 4 specimens for each size weld, from hot-rolled low-carbon steel and were arc welded with $\frac{5}{32}$-in. bare low-carbon electrodes, using 150 amperes current. Berry strain gage holes using 2-in. gage length were drilled in opposite sides of the center blocks of each specimen, as shown in Fig. 1. Strain readings were taken before welding and each time after welding an arm to the center block. One specimen of each size of weld was annealed for two hours at 1,000 deg. F. and allowed to cool in the furnace.

The completed specimens were tested in transverse bending by means of a 200,000-lb. Olsen testing machine. The moment arms used for the bend tests were 10 in., as shown in Fig. 1. Load deflection readings were taken of each specimen by means of dial gages mounted at the ends and the center of the specimen. In Fig. 2 is illustrated a specimen after failure.

Results of the tests are given in the table. The strain gage readings were very erratic because the specimen blanks were only rough cut with a torch and did not fit

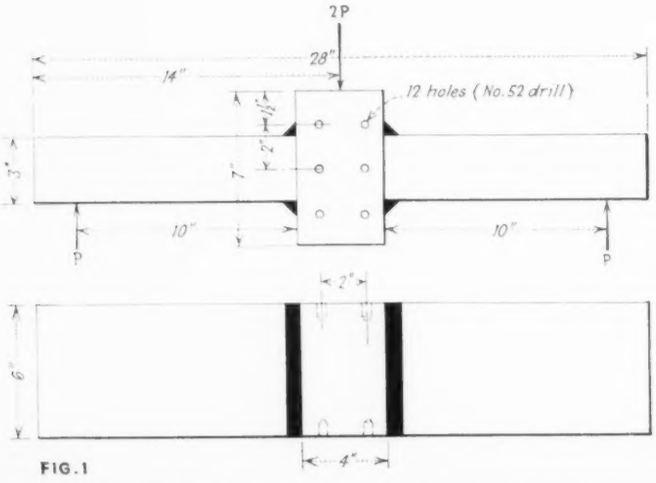
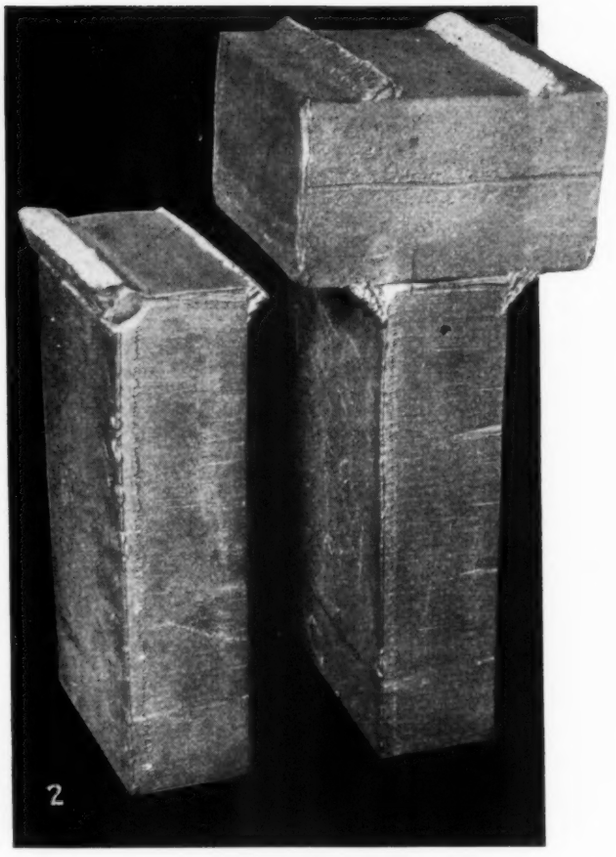
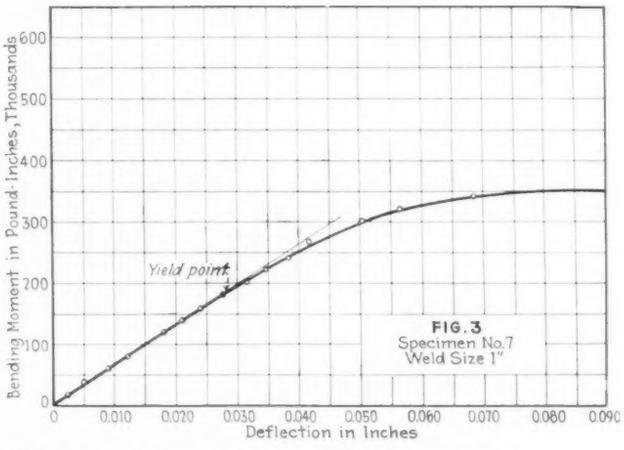


FIG. 1

FILLET WELD bend test specimen showing location of Berry strain gage holes and point of application of load and load reactions



FAILURE of 1-in. fillet weld



TYPICAL bending moment-deflection curve plotted from test data to determine yield point

together evenly. The variation in bearing area between the arms and the center blocks produced large variations in the strain readings for similar specimens. As a result, very little direct information on the values of residual stresses could be obtained from the readings, and they are not tabulated.

Stresses in the arm at the yield point were computed by the ordinary flexure formula, all stress concentrations being neglected. Yield point and the magnitude of the corresponding bending moment was determined from the moment deflection curves of the specimens as plotted from the test data. The load at which the curve deviated from a straight line, as shown in Fig. 3, was taken as the yield point.

Applied weld stresses were computed by the following

in LARGE FILLET WELDS

Within certain limits, the larger the weld the larger the residual stresses present and the lower the yield point and ultimate unit strength. Residual stresses are greatly affected by welding procedure

STRENGTH DATA ON FILLET WELD BEND TESTS

Spec. No.	Size of Weld, In.	Treatment	Stress in Arm at Yield Load	Stress in Weld at Yield Load	Ult. Str. of Weld Lb./Sq.In.
2	$\frac{3}{4}$	None	17,300	16,700	45,000*
5	$\frac{3}{4}$	Annealed at 1,000 deg. F.	20,600	19,900	44,600*
8	$\frac{3}{4}$	None	11,100	10,800	42,600*
11	$\frac{3}{4}$	None	10,300	9,950	41,500*
1	1	None	12,480	9,410	40,300*
3	1	None	16,300	11,500	38,800*
7	1	Annealed at 1,000 deg. F.	16,500	11,700	36,600*
10	1	None	7,500	5,200	37,600*
4	$1\frac{3}{8}$	Annealed at 1,000 deg. F.	17,000	8,620	32,300†
6	$1\frac{3}{8}$	None	15,900	8,800	37,600*
9	$1\frac{3}{8}$	None	12,430	6,200	32,600*
12	$1\frac{3}{8}$	None	13,300	6,700	31,900†

*Failure occurred in tension weld on arm welded first.
†Failure occurred in tension weld on arm welded last.

approximate method:

Let P = end reaction on specimen in lb. ($\frac{1}{2}$ total specimen load)
l = moment arm in inches
d = depth of arm in inches
b = width of arm and weld in inches
t = leg of fillet in inches
s = stress in weld in lb. per sq.in.

Referring to Fig. 4 and assuming that the stress is evenly distributed over the weld, then the bending moment Pl is counteracted by the couple $T(d + t)$. The force T acting on the weld is therefore

$$T = \frac{Pl}{(d + t)}$$

By the conventional method of computing fillet weld stresses, the critical section of the weld, the weld throat, is considered as being subjected to a tension or compression stress equal to the force acting on the weld divided by the throat area of the weld. The weld stress s_m resulting from the moment Pl is therefore:

$$s_m = \frac{T}{0.707\ bt} = \frac{1.414\ Pl}{bt\ (d + t)}$$

The weld stress s_s resulting from the shearing action of force P is

$$s_s = \frac{P}{2(0.707)bt} = \frac{0.707\ P}{bt}$$

The stresses s_m and s_s are tension stresses for the welds on the tension side of the specimen arm, and compression stresses for the welds on the compression side of the specimen arm. The total stress s in the tension and compression welds is obtained by adding the stresses s_m and s_s, from which,

$$s = s_m + s_s = \frac{1.414\ Pl}{bt\ (d + t)} + \frac{0.707\ P}{bt}$$

$$s = \frac{0.707\ P\ (2l + d + t)}{bt\ (d + t)}$$

As mentioned before, very little direct information on residual stress values could be obtained from the strain gage readings taken. These readings did, however, furnish some important information.

After the first arm of a specimen was welded to its center block and the strain gage readings were taken, it was found that, as shown in Fig. 5 at *a*, side 1-2-3 was in compression and side 4-5-6 was in tension. This meant that a bending moment was present in the center block caused by the contraction of the welds. From the condition of equilibrium, therefore, the welds and the section of the arm between the welds were subject to a tensile stress.

This stress condition is clearly shown in Fig. 5 at *b*, where it is assumed that the portion of the arm between

DISTRIBUTION of forces in specimen under test

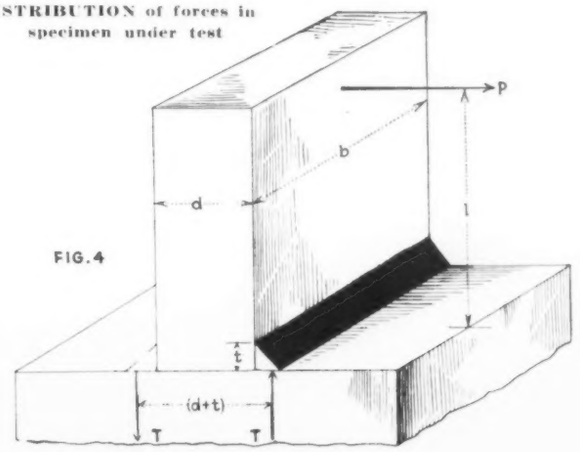


FIG. 4

the weld is replaced by a spring. By placing this spring in tension, corresponding to the arm being in tension, the welds would be subject to a tensile stress, and the center block would be subject to a bending moment equal to the tensile force of the spring times L_1 the moment arm.

In welding the second arm to the specimen the same condition was produced except that the bending moment on the center block acted in the opposite direction. This bending moment aided the condition of stress in the center block by relieving the tensile stress on side 4-5-6 and the compressive stress on side 1-2-3. Also, the welds on arm 2 were subjected to a tensile stress, and the welds on arm 1 were subjected to an additional stress above that initially obtained in them. It is very improbable that the stresses in the welds on both arms would be equal, because in the process of making the welds on the second arm, the additional layers of weld metal would tend to relieve the existing stresses. This annealing effect could in no way affect the stresses in the welds made first.

The fact that the welds on the arm welded first had higher residual stresses than the welds on the arm welded last would indicate that they would fail first during the process of testing. The bend tests proved this to be the case in all but two specimens. One of the specimens that did not fail as predicted had been annealed and the stresses had been relieved. On the other specimen, the weld that failed was slightly under size, this fact probably accounting for its failure.

From the bend test results, the most important conclusions can be drawn from the ultimate strengths obtained. The yield point was significant in that it roughly indicated when yielding occurred, but the instrument set-up was not sensitive enough to determine this point accurately, and in the specimens having the largest welds the first yielding most likely took place in the arms and not in the welds. Hence no great dependence can be placed upon the yield point values that were obtained from these tests.

TENSILE and compressive forces caused by the contraction of the welds produce bending moments in the center block

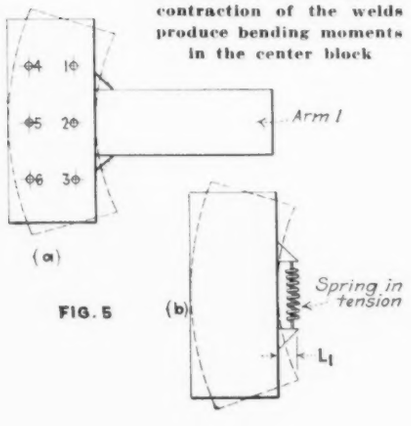


FIG. 5

From the ultimate strengths obtained, it was evident that the larger the weld the lower the unit stress necessary to produce failure in the weld. This indicated that the larger the weld the greater the residual stress present.

Specimens that had been annealed tended to develop a higher yield and ultimate strength than the others. This was possibly because residual stresses had been relieved during the annealing.

With reference to Fig. 2, it will be noticed that failure occurred at two points, the base and heel of the welds. (The weld crack is not noticeable in the photo shown in Fig. 2.) This type of failure occurred in all the 1-in. and $1\frac{3}{8}$-in. specimens. The $\frac{3}{4}$-in. welds failed through the weld throat only. Where double failure occurred, as shown in the photograph Fig. 2, both cracks occurred simultaneously.

From the above investigation the following conclusions can be drawn:

1. The larger the fillet weld, the greater is the probability of obtaining large residual stresses.
2. The larger the fillet weld, the lower is its yield point and ultimate unit strength in transverse bending. The ultimate strengths obtained were:

$\frac{3}{4}$-in. weld	43,500 lb. per sq.in.
1-in. weld	38,300 lb. per sq.in.
$1\frac{3}{8}$-in. weld	33,600 lb. per sq.in.

3. Welds located in a manner similar to those on the test specimens shown in Fig. 1, should be made simultaneously rather than successively, in order to prevent excessive stresses in the first welds.

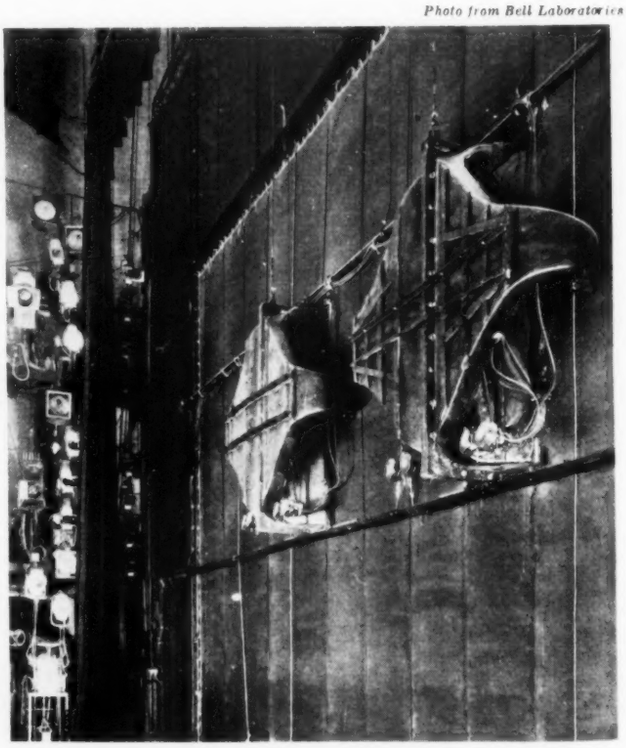
■

A Shallow Horn Design For Efficient Reproduction

STANDARD horn-type loud speakers for Western Electric sound-picture systems are 52 in. deep, too deep for shallow stages or close backdrops, as in the Roxy Theatre, New York City. Engineers had to design horns less than 30 in. deep, yet with fixed rates of taper from small end to mouth, and bends having radii of curvature large compared to sound passage width.

Two major design changes solved the problem. An oblong, instead of square, horn mouth maintained mouth area but permitted division of the air column into two equal branches, thus attaining shorter radii of curvature and a horn only 26 in. deep. Wood, fabric, and metal had like performance characteristics, so $\frac{1}{16}$-in. sheet steel, welded to prevent rattling, was used. An added advantage of the new horn was a sound field of 45 deg. each side of center, while that of the standard horn was but 15 deg.

Photo from Bell Laboratories



ROLLER BEARINGS
for heavy duty

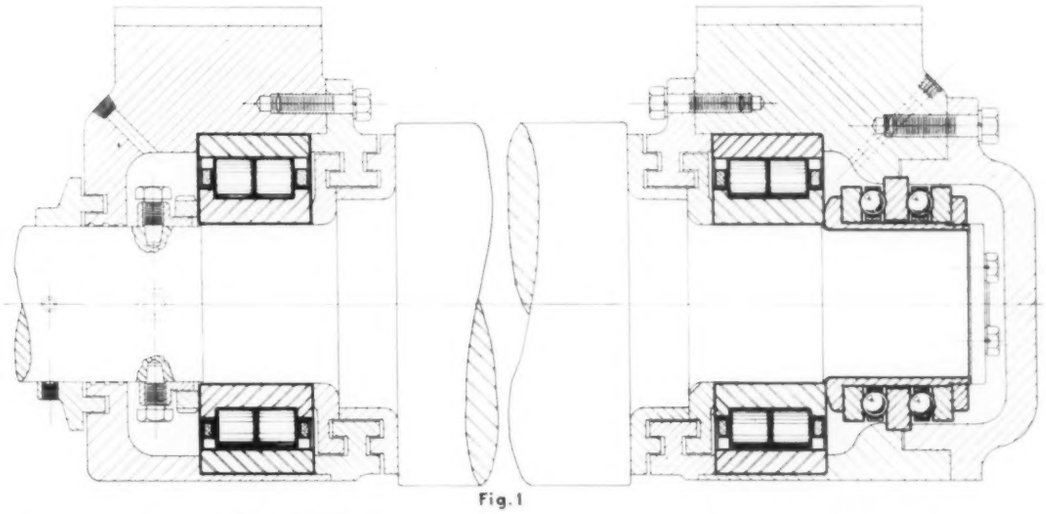


Fig. 1

TOP ROLL BEARING of a two-high finishing mill where limited space is a factor

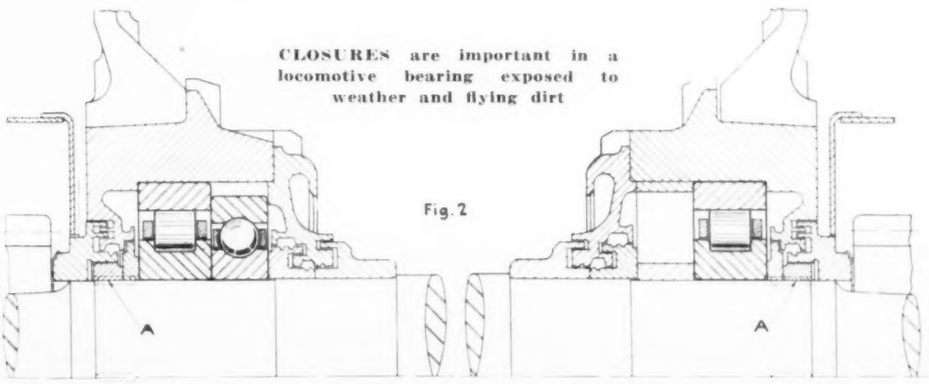
By D. E. BATESOLE
Assistant Engineering Manager
Norma-Hoffman Bearings Corporation

ROLLER BEARINGS are successfully replacing plain sleeve bearings in heavy-duty applications that are a perpetual source of trouble. Often in heavily loaded plain bearings enough friction is produced to make water cooling a necessity, besides calling for frequent renewal of both bearings and shaft. Troublesome bearings are notoriously big consumers of lubricant and demand constant attention. Static friction under these conditions is also sometimes the controlling factor in determining motor sizes. Roller bearings are meeting these conditions successfully. Their low static and running friction, large load-carrying capacity in small space, freedom from attention, and ease of lubrication have offset their higher price and made them the logical selection for severe duty applications.

In the past few years considerable progress has been made in the application of roller bearings to steel mill roll necks. Here the conditions that must be met are high load-carrying capacity, limited space, and the presence of dust, scale, and water. In Fig. 1 is shown a typical solution of this problem as applied to the top roll of a two-high finishing mill. Bearing capacity is obtained by double-row cylindrical bearings with rollers of the same diameter as length to give uniform distribution of the load over the roller and to prevent skewing action of the rollers with the possibility of overloading at the extreme ends.

End thrust, which is always present, is carried on a double direction ball thrust bearing at one end of the roll. Proper performance of this bearing when mounted on a horizontal shaft is contingent on the absence of endwise play to maintain the balls in their grooves. This is accomplished by an inner sleeve with a shoulder and adjusting nut which makes the bearing a self-contained unit. The same bolted plate at the end of the shaft holds both thrust bearing sleeve and roller bearing in position.

At the drive end of the roll a special construction was used to lock the inner race in place without the conventional locknut. Threads cut in the shaft



CLOSURES are important in a locomotive bearing exposed to weather and flying dirt

Fig. 2

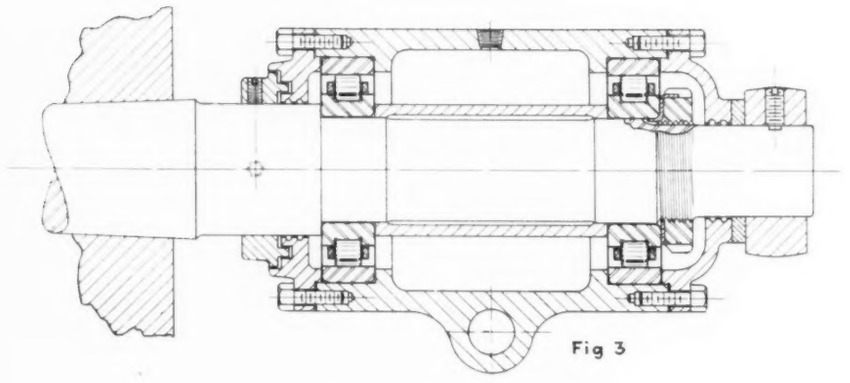
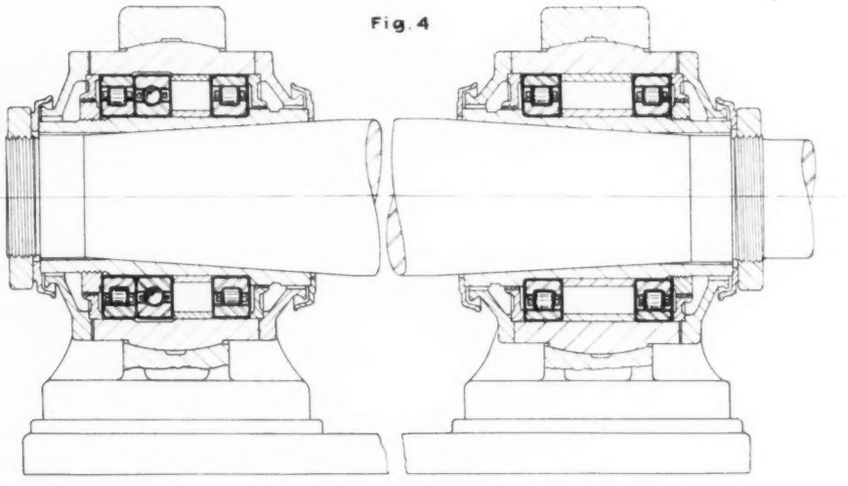


Fig 3

SELF ALIGNMENT in a vertical plane in a large band saw bearing is obtained by means of a pin-pivoted box and two-bearing construction

Fig. 4



A HEAVY-DUTY pulp mill bearing where continuous heavy loads are encountered, and where the bearing must be sealed against entry of water

MAIN SHEAVE BEARING in a gearless elevator where the dead shaft is used with revolving outer races. The bearing is subject to severe shock loads

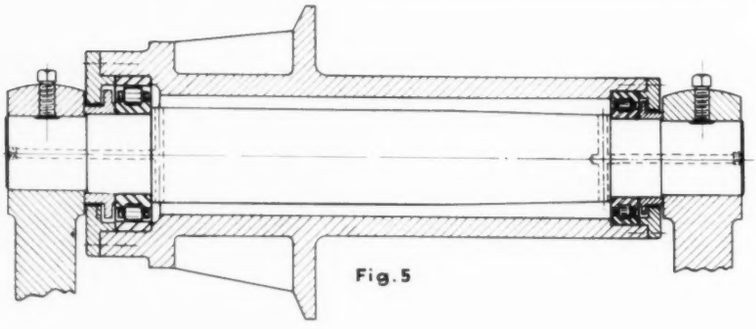


Fig. 5

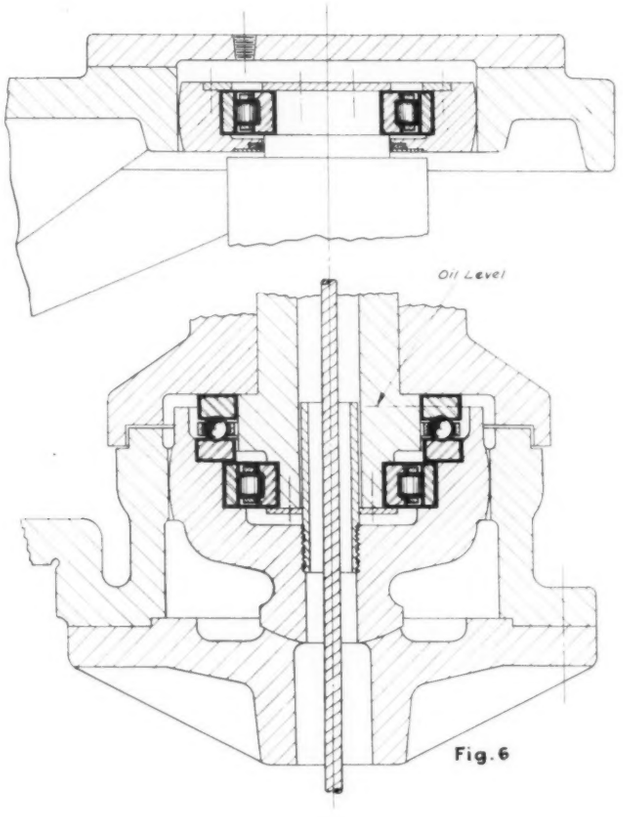
tend to weaken it and cause fatigue failure under the rotating bending moment imposed by the overhung gear load. By cutting the thread for the locknut on an auxiliary sleeve fastened to the shaft through taper setscrews, this danger is obviated.

Adequate protection of the bearings against the entrance of water and mill scale is provided by the double labyrinth inclosures. For assembly reasons the shaft flingers are made in two pieces. The radial running clearances between them and the grooves in the cover plate may safely be made small, but larger axial clearances are necessary to compensate for errors in manufacture and assembly. On account of the limited distance between roll centers, the housings have been cut off at the lower side. It is also necessary to allow for a reduction in roll diameter when grinding or re-dressing the rolls. Grease lubrication is provided, and helps to seal the housings at the labyrinth inclosures.

Even more elaborate inclosures are provided on the heavy traction motor for an electric locomotive, shown in Fig. 2, because the bearing housings are subject to severe weather conditions, including snow, ice, rain, and dust, being in a relatively exposed location close to the ground. The design shows the armature shaft of a 500-hp. d.c. motor with its double pinion drive through spring-cushioned gears. Separate bearings are provided on the motor frame for the driven axles which serve to partially support the weight of the motor and to keep the gears in alignment. One single-row cylindrical roller bearing at each end provides radial capacity for the overhung pinion loads. During acceleration and on grades these loads may be high, around 20,000 lb. at 100 r.p.m., decreasing rapidly as the motor comes up to speed around 500 r.p.m., which is within safe limits for a bearing having a bore of 6 in. and an outside diameter of 12 in. Maximum speed of this motor may be as high as 1,450 r.p.m. Thrust developed from inertia effects around curves and due to unevenness of track is carried on a separate deep-groove ball bearing, located radially free in one housing. For manufacturing economy both housings are alike, necessitating the use of sleeves in the other housing to absorb the excess space.

All inner races are shrunk on the shaft and in addition are clamped endwise by means of locknuts threaded over collars that are keyed to the shaft. After the pinion is pulled home on its tapered seat and held with its locknut, the bearing clamping nut is backed outwardly until tight, then locked in place.

Wheel bearings for large size band saws is another heavy-duty application where the roller bearing is of advantage. In Fig. 3 is illustrated one of the upper housings for a 10-ft. band mill. Self-alignment in a vertical plane must be provided to allow for vertical adjustment of one housing to control saw trackage, and



STATIC FRICTION is a leading factor in this jib crane thrust bearing. Both upper and lower housings are self aligning

is attained through the pin-pivoted box and two-bearing construction. Bearing loads are definite and easily established from the wheel weight and the weighted saw tension. End thrust, largely accidental and hence indeterminate, is carried by set collars at the outer end of each housing. With a sleeve bearing this combination of load and speed necessitated a water-cooled housing, a constant source of trouble in winter as these machines are generally operated out-of-doors, under a shed. Roller bearings obviate this difficulty and make increased saw tension and consequent higher peripheral speeds possible. Plain bearings were always wasters of oil, some machines actually consuming 10 gal. of oil in 24 hours. In comparison, the roller bearings consume about a half pint a month. Entrance of sawdust is prevented by a slinger and labyrinth seal in combination with oil grooves.

Similar conditions of continuous and definitely determined heavy loads are found in magazine-type wood pulp grinders used in the early stages of paper making. Against a large and heavy grindstone, 54 in. in diam. and 27 wide, three bundles of wood are pressed under hydraulic pressure. In addition there may be an overhung belt or gear load, besides the working torque. Frictional losses and heating troubles of the plain bearing make the roller bearing the logical selection. A typical application is shown in Fig. 4.

Several features are noteworthy: tapered sleeve construction to facilitate removal of bearings and housing intact for installing new grinder stones; cylindrical roller bearings spaced well apart in pairs in ball and socket self-aligning housings; and adequate inclosures against the entrance of water, present in quantity as a medium for cooling and carrying away the pulp fibers. A slinger attached to the shaft carries off most of the water during rotation, and any water that may enter the first cover plate escapes through a drain opening at the lower side. A still further barrier against the ingress of any moisture is furnished by an inner cover plate with three oil grooves, so that even when the machine is washed down with a hose when standing still, no water will enter the inner inclosure.

As in the example of railway motor bearings, endwise stabilization is by a deep-groove ball bearing, mounted radially free.

A mounting in which the outer races revolve and the inner are held stationary is illustrated in Fig. 5, showing the main sheave and motor armature of a gearless elevator. One of the principal reasons for using a dead shaft is that accurate alignment of the bearings is assured without resort to self-aligning bearings or housings. The bearings are subjected to severe shock loads, especially when the "safety" is set in an emergency. These overloads are of considerable magnitude and must be allowed for when selecting the bearing sizes. Endwise location of the armature is taken care of by the two-lipped or self-contained roller bearing at the small end of the shaft. Tests have shown that the low starting friction of the roller bearings has a marked effect on the control of the car and on the power required, particularly where the elevator is in local service, with frequent stopping and starting.

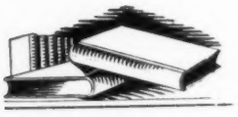
Another application where static friction becomes the leading factor is in a jib crane, Fig. 6. While the thrust load is the principal one and must be taken on a separate ball thrust bearing, a considerable radial load is developed as a couple to resist the overhung weight at the end of the jib. Both upper and lower housings are self-aligning, the lower being a ball and socket design. A lip on the casting supporting the thrust bearing limits the height of oil in the bearing, and a section of pipe on the inside acts as another dam against overflow into the hollow column through which the electric cable passes. Either oil or grease lubrication may be used for the upper bearing, the former being preferable.

■

Erosion-Resistant Materials Required for Steam Turbines

STAINLESS STEEL at present seems best suited for the long blades on present-day high-speed steam turbines, according to A. G. Christie, in a paper at the Midwest Power Engineering Conference in Chicago. One steel, containing 12 per cent chromium and 0.1 per cent carbon, has given much promise. Plating the edges of the blades with erosion-resisting materials such as chromium appears to have possibilities. Sprayed coatings of tantalum, coatings of Stellite, and nitrided blades are being further investigated. Blade speeds in larger turbines have been increased to a point where tip speeds are now as high as 1,150 ft. per sec., the trend being toward still higher speeds. Rapid erosion of the blades occurs because of the large heat drops at high efficiency which result in high moisture content of the exhaust steam. Limiting temperatures in turbines have so far been fixed by properties of available materials, and can be increased with the development of alloys capable of resisting "creep" at temperatures above 1,000 deg. F.

Books for Engineers



COMPRESSED AIR PLANT, FIFTH EDITION. *By Robert Peele, Mining Engineer and formerly Professor of Mining, School of Mines, Columbia University. 554 pages, 5⅞x9 in. Indexed. Illustrated. Clothboard covers. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price $7.50.*

DESIGNERS and engineers who encounter design problems in equipment for the production of, transmission, and use of compressed air will find this rewriting of a standard text a complete, authentic, and up-to-date volume for ready reference. Much tabular matter and many illustrations lend additional clarity to the catalog-like text, and the author's explanation of the theory of air compression and its application to the design of equipment is straightforward. Full derivation of important formulas, outline specifications and characteristics of the various makes, and comparisons with steam and electric systems are included, as well as characteristics governing design and use.

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THE WORLD'S ECONOMIC DILEMMA. *By Ernest Minor Patterson, professor of economics, University of Pennsylvania. 323 pages, 5½x8½ in. Bound in cloth boards. Published by Whittlesey House, McGraw-Hill Book Company, Inc., New York, N. Y. Price $3.50.*

WHILE not exactly sprightly, Prof. Patterson's development of a difficult subject runs along smoothly and should prove enlightening to thoughtful men in every walk of life. He explains logically what the present dilemma facing the nations is, and how they got themselves into their present difficulties. In addition to the general treatment of the world problem, he gives separate chapters on the situations in England, France, Germany, Italy, Japan, and the United States.

Prof. Patterson points out the conflict between political and economic expediency, and says quite frankly that political considerations may often be more potent than economic requirements. He comments at some length on the question of restricted immigration. Politically, a nation claims the right to exclude other nationals for various reasons. Economically, has that nation the right to prevent other nationals from exploiting natural resources? Political considerations have decided the point, so far.

True to his title, Prof. Patterson contents himself with stating the dilemma. He does not attempt to get us out of it. And what a task that is going to be! Few men have a thorough conception of how difficult the dilemma is; the others will profit by a careful reading of Prof. Patterson's book. Manufacturers who have read it may not be quite so insistent on high protection after they have studied all the various political and economic effects of such protection in a world of nations that are becoming steadily more dependent upon each other.

STANDARDS AND SPECIFICATIONS FOR NONMETALLIC MINERALS AND THEIR PRODUCTS. *Misc. publication No. 110. 680 pages, 8x11 in. Cloth board covers. Indexed. Published by the Bureau of Standards, U. S. Department of Commerce, and sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price $2.75.*

AN ATTEMPT has been made in this book to present all of the nationally recognized specifications for such commodities as stone, sand, clay products, glass, mica, graphite, and nonmetallic minerals. In general, the specifications are given in full, including such matters as testing, preparation of samples, and the apparatus for testing. The data came from more than seventy trade and technical organizations. The compendious nature of the book makes it difficult to use as a quick reference or as a text, but it should be of value to anyone having to prepare detailed purchase specifications.

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A.S.T.M. STANDARDS, 1930 EDITION. *Part I—Metals, 1,000 pages, Part II—Non-metals, 1,214 pages. 5¾x9 in. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. Price, cloth board covers, $7.50 either volume, or $14 for both; half leather, $9 either volume, or $17 for both.*

A.S.T.M. STANDARDS, issued triennially, are recognized as authoritative in the field of engineering materials. The present edition contains the 430 standards adopted by the society, 179 dealing with metals and 251 on non-metals.

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EXPERIMENTAL MECHANICAL ENGINEERING, VOL. I, ENGINEERING INSTRUMENTS. *By Herman Diederichs, director of the Sibley School of Mechanical Engineering, Cornell University, and William C. Andrae, assistant professor of mechanical engineering, Cornell University. 1,069 pages, 5¾x9 in. Cloth board covers. Published by John Wiley & Sons, 440 Fourth Ave., New York, N. Y. Price $8.*

AS STATED in its preface, this book is an entirely rewritten text based upon the seventh edition of the Experimental Engineering by R. C. Carpenter and H. Diederichs. This present volume is confined to the construction, use and calibration of engineering instruments for measuring length, area, time, speed, pressure, temperature, work, and power. More than 100 pages are devoted to steam engine indicators. Other chapters treat of the properties of gases, determination of moisture in steam and heat values of fuels, measurement of liquids, gases and vapors, fuel analysis, flue gas analysis, and lubrication.

Extended treatment of theory, and the breadth of field covered, characterize the book. This is particularly noticeable in the chapters on the engine indicator, speed measurement, and measuring the flow of fluids.

how BEARING CLEARANCE, JOURNAL DEFLECTION, and OIL GROOVES affect LUBRICATION

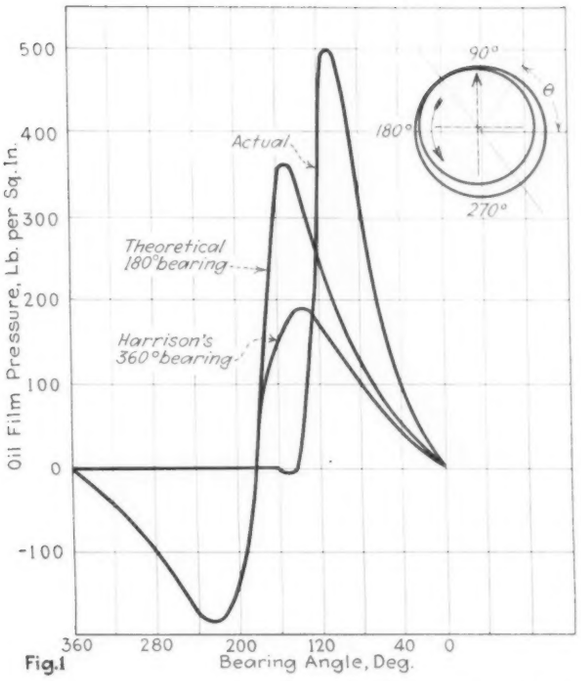

Fig. 1 OIL FILM pressures as determined by theoretical equations and actual measurements

By L. J. BRADFORD

Professor of Machine Design, The Pennsylvania State College

DURING the course of his investigations in the field of lubrication in 1883, Bauchamp Tower noticed, among other things, that pressures existed in the film of lubricant separating the journal and bearing which were far above those at which the lubricant was supplied. This phenomenon interested Osborne Reynolds, the eminent physicist, and in 1886 he published in the Transactions of the Philosophical Society of London, a mathematical explanation of the conditions Tower had shown to exist in the oil film. This analysis has since been simplified and extended by Harrison, Sommerfeld, and others. However, but little experimental work has been published to substantiate the conclusions arrived at by these scientists.

For the last three years work has been going on at The Pennsylvania State College, having for its objective the accurate determination of the distribution, both longitudinal and circumferential, of pressure within the film of a sleeve bearing completely surrounding a journal. The results obtained so far, together with a detailed description of the machine used and technique followed have been made the subject of Bulletin No. 39, published by the Engineering Experiment Station, The Pennsylvania State College.

Briefly, the machine used in conducting the lubrication researches at The Pennsylvania State College consisted of a heavy bearing shell, lined with babbitt, which rested in a heavy cast-steel yoke. The bearing was without grooves, lubrication being supplied by exposing one entire end of the bearing to oil at a pressure of about 9½ lb. per sq.in. The bearing was drilled with four holes placed at different axial positions, and these holes were connected to gages, so that the pressures in the oil film at the points where these holes entered the bearing might be read. The bearing was arranged so that it could be rotated in the yoke, and thus pressure traverses of 360 deg. each might be secured at four different axial locations. Micrometers were also arranged so that the location of the shaft with respect to the bearing might be measured.

A typical pressure curve obtained from the hole at the center of the bearing is shown in Fig. 1. Plotted on the same figure are curves showing the pressure distribution plotted from Harrison's equation, first for a complete bearing, and second for a partial bearing extending around the journal for 180 deg. The difference between the two is striking. A careful analysis will show that the bearing is not as good a one as that assumed by Harrison because the eccentricity of the shaft with respect to the bearing is greater. This means that the minimum thickness of the oil film is less in the bearing in the experiment than in one that reproduces Harrison's conditions, and consequently the danger of failure is increased.

Curves showing the longitudinal distribution of pressure are shown in Fig. 2. At low pressures these curves are roughly parabolic, while at high pressures they are saddle shaped. This change in form is due to deflection of the shaft within the bearing. Inasmuch as the maximum shaft deflection within the bearing was only

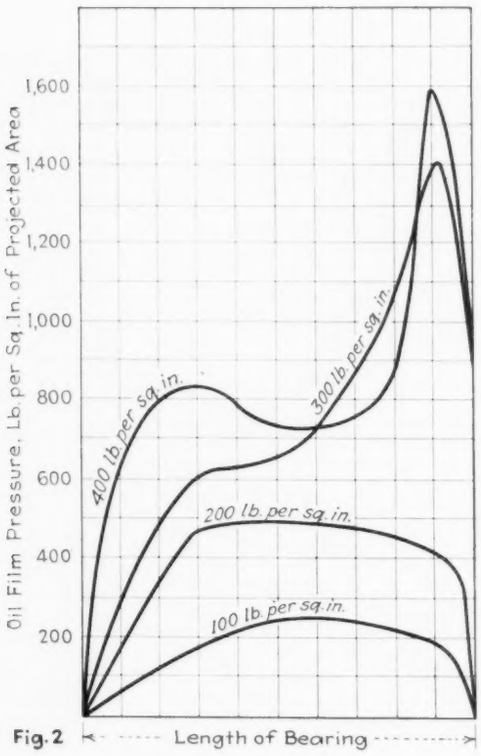

Fig. 2 **LONGITUDINAL distribution of oil film pressures for various loads**

about 0.00086 in., these curves serve to call attention to the extreme sensitiveness of bearings to their geometrical dimensions. They emphasize the fact that refined calculations of bearing performance are useless unless accompanied by equally refined workmanship. They also indicate that if long bearings are fitted so that the clearance between the shaft and bearing is small, the deflection may be great enough to cause the shaft and bearing to come into metallic contact at the ends and thus cause local heating.

It is interesting to note that at a journal speed of 320 ft. per min. it was readily possible to maintain a complete and unbroken oil film with pressures as high as 400 lb. per sq.in. of projected area. Also it was found that under these conditions the temperature of the bearing did not rise more than 35 deg. F. above room temperature, although no means of heat dissipation other than normal radiation was provided.

The oil film minimum thickness was found to be considerable in all cases, except where the load reached 400 lb. per sq.in. of projected area. For a load of 100 lb. per sq.in. of projected area the minimum thickness was found to be 0.0017 in. while for 300 lb. per sq.in. it was 0.0006 in. These minimum thicknesses give some indication of the degree of precision that must be attained in bearing manufacture if complete separation of the rubbing surfaces is to be secured. Projections on either bearing or journal extending above the surrounding surface for a distance equal to the minimum thickness of the oil film will undoubtedly break through this film and establish metallic contact with the opposing surface, causing local heating.

The distribution and intensity of oil film pressure should be of interest to the designer because of its relation to the location of oil grooves, and point of application of the lubricant. Maximum pressures are shown to range from about 200 lb. per sq.in. to about 1,500 lb. per sq.in., depending upon the load sustained by the bearing. While these values are true only for the particular bearing experimented with, they furnish some idea of what may be expected in any bearing in which complete separation of the rubbing surfaces occurs. Negative pressures as high as 10 in. of mercury are found to exist in other parts of the bearing.

The curves of oil film pressures teach two important lessons. First, it is entirely useless to try to introduce oil in the region of positive pressure, unless it is supplied under pressures greatly in excess of those usually employed. One cannot get oil at 50 lb. per sq.in. to enter a region occupied by oil at 500 lb. per sq.in. Second, any grooves cut in the bearing so as to connect regions of high and low pressure will certainly facilitate the escape of the oil from the high pressure region where it is most effective in supporting the load imposed on the bearing. These facts are too often ignored by designers.

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When the Engineer Encounters an Industrial Transformation

CONTINUED FROM PAGE 101

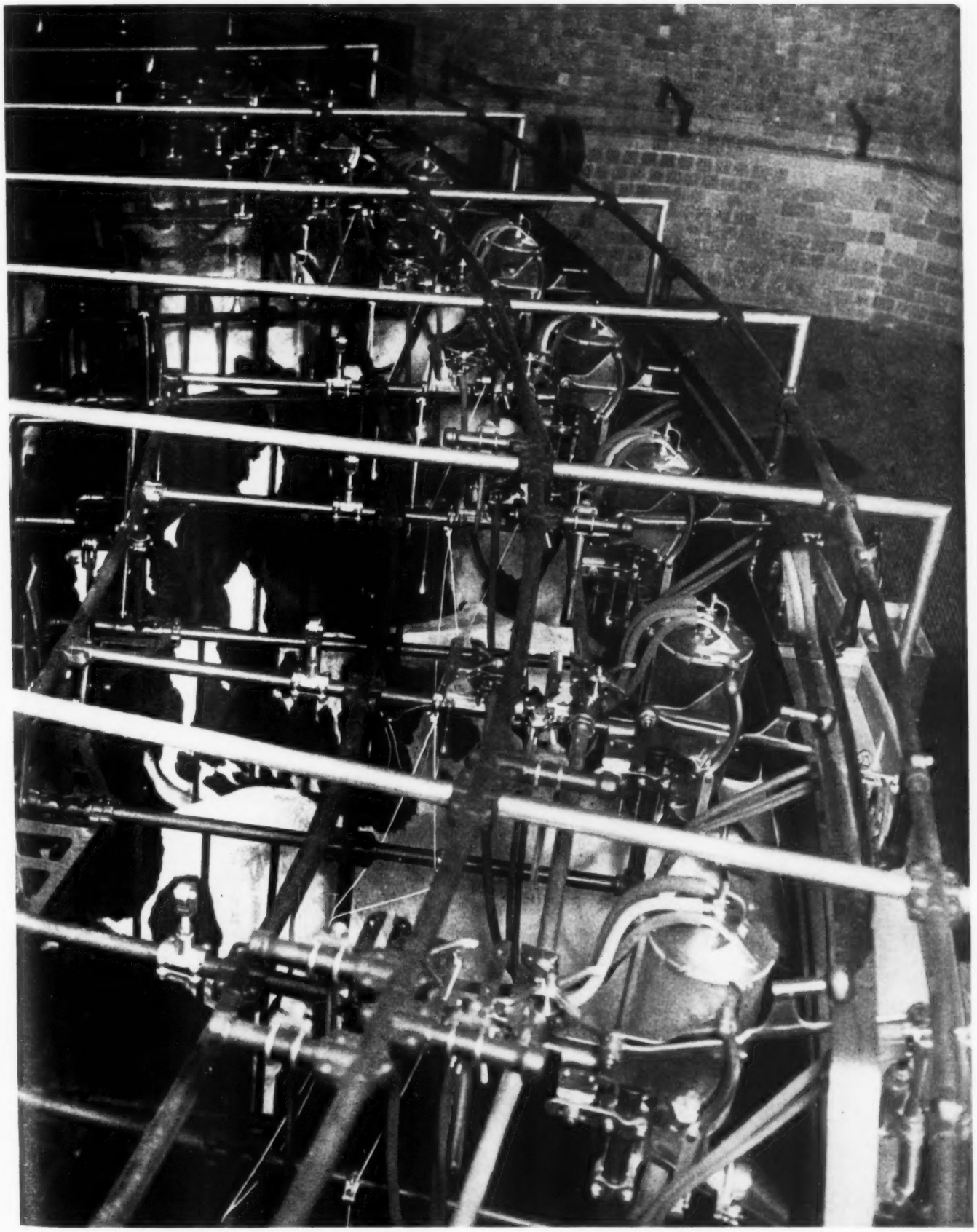
rolls upon leather-faced rollers. An arrangement of cables, adjusted so that positive action is possible, takes care of forward and backward motion of the sliding member.

Every studio has worked out in its own way the problem of suspending the microphone from the boom end. One of the most ingenious is now used by Pathé Studios. The device as used there consists of a rubber diaphragm about 6 in. in diameter, with the microphone suspended from the center of this disk. The arrangement does away with the possibility of telegraphed sounds being transmitted through the boom to the microphone and to the recording circuit. A spherical cover of gauze, which may be seen in several of the illustrations, keeps wind noise from affecting the microphone in outdoor recording.

The microphone as it now exists consists of a condenser transmitter, the biscuit-like object which can be seen in several of the photographs, attached by means of a swivel joint to the end of the long metal tube. Within the tube is an amplifier, either one or two stage, depending on the type of sound to be recorded. The transmitter may be turned in any direction, and a decided directional effect is noted in recording sound. Various devices have been rigged up which enable an assistant to face the microphone in any direction to take advantage of this effect.

In answer to the demand for a boom which might be operated in precarious positions, the Mole-Richardson Company has been manufacturing a smaller boom which embodies a compensating counterweight. This counterweight moves backward 1 ft. for every 3 ft. the boom arm is extended, keeping the assembly in a state of equilibrium. This type of boom is especially adaptable for portable recording units.

The problem of silencing auxiliary apparatus, and at the same time imposing no additional limitations upon the shooting of the picture, is one which has not yet been entirely solved. While the booms and blimps in use today are far in advance of anything which had even come to mind two years ago, continuous efforts are being made to improve these items and the quality of the recorded sound as it is released from the studios.



THE ROTOLACTOR — engineering's contribution to quantity production of certified milk

Design problems faced in this unique machine will be told in detail in the next number of Product Engineering. *Development of the machine required a preliminary study of the habits of the animal as well as of the economic requirements of milk sales*

COMMENT AND SUGGESTION

A Striking Mechanism

By F. R. Zimmerman

A RAPID movement of the hammer, X to X', is obtainable by the mechanism shown in the figure, or a striking action may be developed at a distance by the addition of a connecting link (not shown).

The operation of this mechanism depends upon a heavy tension spring,

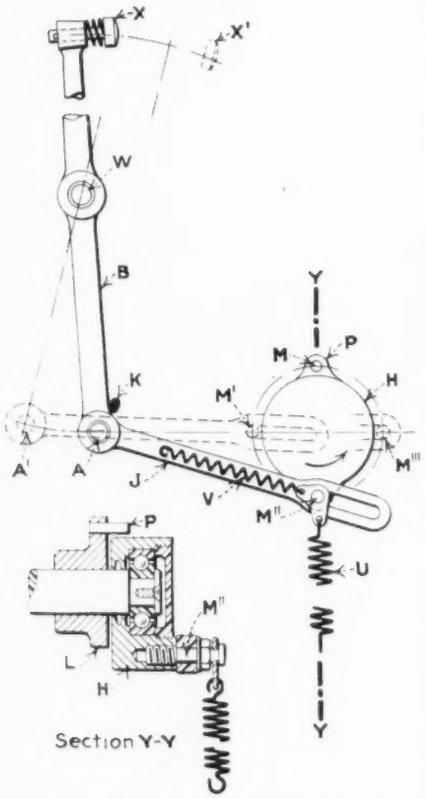


Diagram of hammer-operating mechanism, showing successive positions of the link J and connecting parts

U which pulls pin M to point M' and then to M''. Pin M is constrained to move in a circle because it is mounted on the rim of wheel H which in turn is carried on the end of a uniformly rotating shaft. The ball bearing permits of rapid and easy turning action.

Hub L is keyed to the shaft and carries pin P, the function of which is to rotate the pin M to the position M'' and then to position M where it is just ready to pass dead center, or is at the "firing point." Pin M is held at the left end of the slot in link J by the light spring V, during part of the cycle, but as the pin M revolves from M'' to M''' to M it moves in the slot because the stop pin K prevents the link B from moving beyond the position shown. The actual striking action is in proportion to the movement obtained by the pin M as it operates through the second half of the circle. Pin M remains at position M'' almost half of the time required for one rotation of the shaft. It then consumes almost another half revolution in arriving at the "firing position," after which it rotates from M to M' and then to M'' almost instantly, causing the link B to swing through an arc about the pivot W and the hammer X to strike its blow.

STOP . . . LOOK . . . LISTEN . . .

ON WITH THE NEW!

HIGH cost of tin two years ago accelerated research to find substitutes, and with much success. Then consumption declined and the price fell off. Now it appears that the British Metals Research Association formed a committee and spent 1930 finding new uses for tin—and with much success also. . . . It goes to prove that nothing is static in the things that make for product development.

BOOTLEGGER DESIGN

BOOTLEGGERS, usually pictured as worst among Society's malefactors, deserve some credit as its benefactors, for they are paying for the design of products which will be of decided eventual benefit. Designers are perfecting new high-speed pay-load cruisers, airplanes, motor trucks—either directly or indirectly for bootlegging interests. Remote control units and portable directional radio sets are being built, copper-bound tubes 4 in. in diameter have been found stretching for over a mile in a city sewer, and experiments are aiming to perfect a cheaper alcohol—which may prove of value as a fuel when gasoline supplies fail.

HOW MANY ENGINES?

AERONAUTIC engineers agree that the number of motors necessary is the number required to maintain the airplane in flight, but when one tries to determine the exact number, there are arguments for single-, twin-, tri-, and four-motored planes. It would appear that safety is not so much a matter of the number of units in a power

Rear Engine Mounting

By Thomas J. Litle

Director of Engineering, Holley Carburetor Company

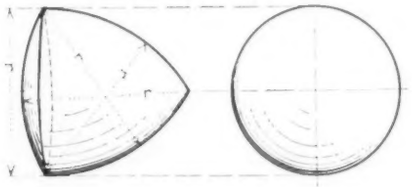
IN THE automotive industry we must admit that much of the early engineering was of the "barnyard variety." In fact, it might be said that there was no early engineering. When it was proposed to replace the horse by mechanical power the replacement was carried out literally. The engine was placed where the horse had been, in front of the vehicle. Then again, early automobile designers took a leaf out of the steam locomotive constructors' book, placing the power plant in front.

I see no reason why the power plant should not be placed at the rear of the vehicle. If some engineers desire to drive through the front wheels they can run a propeller shaft to the front, but I would consider it more sensible to keep the drive in the rear. The better disposition of the passenger load between the two axles is highly desirable. The center of gravity of the vehicle could be lowered, and as previously pointed out, the body builder could provide more body room on a given wheelbase. In inaugurating such a radical change, great care must be taken to avoid freakish and bizarre body designs. Many engineers, probably, would prefer to place the radiator at the front of the vehicle to utilize the natural draft rather than provide additional air ducts and engine fans.

Conic Ovates Roll Like a Ball

GEORGE E. WITTE

WHO says, "Nothing rolls like a ball?" If you have a little spare time, turn a conic ovate out of a piece of hard wood. The accompanying sketch shows how it should be proportioned. Place the conic ovate on a flat surface and rest another flat surface on top. Hold the top one so that the two surfaces will always remain parallel. As the upper surface is moved in its plane, the conic



Spheric ovates resemble a cone the surface element of which is a circular arc of radius *r*, the base a spherical surface of radius *r*, and the diameter at the base also equal to *r*

ovate will "roll like a ball," that is, will keep the two surfaces a constant distance apart.

Of course, if one tries to roll the conic ovate by throwing it across a flat surface, it will perform erratic gyrations and very soon come to rest. In that respect it certainly does not roll like a ball.

The peculiar property of the conic ovate has possibly led to its use in automatic machinery. At least the principle on which it is developed has likely been applied to the design of cams or similar machine elements. Perhaps some readers can cite examples of its application.

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What's In a Name?

BY JOHN TALBOT

J. A. POUCH, on page 75 of *Product Engineering* for February, advocates the commemorating of the work of scientists and engineers by the naming of their new developments after them. I am forced to take issue with him; and am certain that many development men deserve no such credit for their work. In the past, most discoveries resulted from the work of individuals working on their own initiative and with their own funds. The only recognition most of them received was a posthumous naming of their discovery after them, a procedure which did little to mitigate their earthly tribulations or pay their rent.

Nowadays, much of the cost of development work is borne by companies instead of individuals. The individual designer or engineer receives payment for his developmental services just as the bricklayer, the machinist, and the sweeper receive payment for their technical knowledge or physical exertion. When a new design or an invention results, from a company engineer's researches, it is the company that deserves the major share of the credit. Further, in the isolated cases where a development is the work of an individual on his own time, the custom is still to give his name to the project—witness the Edison lamp, the Ediphone, Marconi wireless, DeForest vacuum tube, Sperry gyrocompass, Claude neon light, and dozens of other developments.

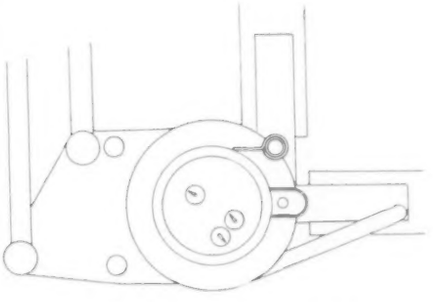
■

Thumb Tack Pad on Drafting Machine

BY L. COON

Draftsman, Kellogg Manufacturing Company

TO ADD to the convenience and time saving qualities of the drafting machine, it is well to provide on it a thumb tack pad. Otherwise, the tacks must be kept to one side of the



A cork pad is glued to the palm block

table, and often the loose tacks become strewn on a drawing with the possibility of tearing it. A convenient place to put such a pad is shown in the accompanying illustration; that is, on the palm block of the machine. such a pad can be made of cork or soft wood with the end grain uppermost. The pad should not be thicker than the length of the tack being used, and about $2\frac{1}{4}$ in. in diameter, so that it does not interfere with the operation of the machine.

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FINISH STANDARDS

WHEN "finish all over" appears on a drawing, just what does it mean? Does it mean to remove the scale from the parts not dimensioned, or does it mean to give it a fine finish? And if so how fine? Is it to be smooth, or polished, or both? For it can be either without the other, what used to be called "a high polish and a deep scratch." But how is the workman going to know what is meant?

•

. . . THE URGE TO MERGE . . .

THE Siamese twins might be chagrined today to witness the arrival of a number of competing duplex units, including radio-talkie, clock-light, and clock-radio outfits, fan-light, maplight, waffle-iron-grill, even hammer-drill combinations—all creating sales arguments for combined products which alone might appear much less attractive. Some waggish designer may even produce a combination vacuum cleaner, lawn mower, and hair clipper that will function with perfect security until some day when we pull the wrong switch.

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. . . FAITHFUL OLD DOBBIN . . .

THE old saw about the fact that there are just as many horses in use as there were before the automobile age may also be true about the good old fashioned flat belt. In spite of the inroads of direct-drives, V-belts, and chain drives there seems to be places where the "old hoss" still serves. A new design of a certain textile machine has more than fifteen flat belts. It goes to show that nothing is universal, or fits all occasions.

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. . . THAT ENGINEER! . . .

MANY men associate the engineer only with the design room, others make him a practical executive, others consider him a technical graduate who wrestles with calculus, still others consider him a State-licensed individual; the public pictures him as a locomotive driver. Then, there are sales engineers, dental engineers, stationary engineers, mortuary engineers, and a host of others. But what, in the final analysis, fits a man for the title of "Engineer"? A recent A.S.M.E. questionnaire, though not especially planned to do so, may shed some light on the question; the new "Who's Who in Engineering" may shed more. There is certainly need for accurate definition on the appellation!

PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

March, 1931

. . . *"1931 will be a year of great opportunities"* . . .
—ROGER BABSON

A Product Will Lead the Revival

IF IT is true that history repeats itself—and there is plenty of circumstantial evidence for the affirmative—then some product, some creation of a product engineer, will lead the way to business revival from the 1930 depression. The Yankee clipper ship opened the way in the dark days of 1837; the electric dynamo introduced a new era in 1873; the bicycle came along in 1893 and developed faster even than the radio of 1921; the automobile broke up the depression of 1907. What is to be our salvation in 1931?

The answer to this question is not apparent, but some of the possibilities were canvassed at the January meeting of the American Institute in New York. One speaker told of the possible applications of ultra-violet rays for the betterment of health and for interior decorations. Another pointed out the suddenly awakened interest in electric clocks and the extensive sales during the last few months. An army officer explained the revolutionary effect of the airplane on plans for national defense, and a scientist described the instruments that have recently been developed to make flying safer, particularly when visibility is low. Manufactured weather is just on the horizon, and the refrigerator makers have been unaware of a depression. Their sales in 1930 were ahead of 1929 sales, and they are looking confidently to better business in 1931.

In *Product Engineering* for February there was an editorial review of the tendency toward less expensive units in many lines of product. Perhaps our salvation lies in one of these smaller brothers of existing products, perhaps not. But it does lie in some creation of the product engineer's brain, and we must look to him for leadership.

■

Crosswords

FIVE HUNDRED words express the average man's ideas; his most educated contemporary rarely uses more than six thousand. The engineer differs from both categories. He must express himself in ordinary language when explaining engineering ideas to non-engineers, but must express an exact engineering idea to another engineer.

In the vocabulary of the average man there are endless synonyms—witness the ever-popular crossword puzzle—but in the engineering vocabulary exactness is more essential. Each word must be used accurately, otherwise there can be no agreement or understanding on specifications, reports, or instructions. For example, there are more than three thousand materials in common use, with each of which the first-rate engineer is supposed to be conversant. Each material has its name; there are rarely synonyms. And so through the entire gamut of engineering. "Variable-speed motor" does not mean varying-speed motor nor does "chromium-nickel iron" mean nickel-chromium iron—these little careless slips only mean mistakes and misunderstandings. Approximate synonyms are dangerous; they tend to make engineering just another crossword puzzle.

■

The Cost of Change

CHARLES F. KETTERING, genial director of research for General Motors, and epigrammatist extraordinary, remarked at the S.A.E. dinner that "it costs a lot to make a change in a product, but it costs a lot more not to make it."

One need not go outside the automobile industry to find proof for Mr. Kettering's observation.

One of the member companies of his own organization introduced, a year or two ago, a model that failed to "click." Then the heads of this company spent a small fortune on sales promotion trying to put it over. They avoided the tremendous cost of a model change in mid-season, but they lost many times what they would have spent on the change before they regained public favor with a radically different product.

Another automobile manufacturer made the mistake of outstaying his market with a small car which sold largely on price. In his case the cost of a model change would have foundered any ordinary company, but what he lost while he was out of the market during the period while a new model was being developed would have broken all but a very few of America's largest manufacturers.

Because of the great size of automobile plants in this country, the complexity of the manufacturing organizations, the risk involved in any new development that swings very far from the accepted standard or style, American automobiles have not shown many radical advances in recent years. The same restriction handicaps any industry where large-scale production and a tremendous equipment inventory are concerned. There is all the more reason, therefore, for engineers in these industries to be forearmed against the dread of change which is sure to rule the production executives. The only way to overcome this dread is to keep constantly in the foreground the specter of an even greater expenditure if the change is not made.

■

Standardization or Stultification?

WHEN a designer begins to think in terms of "averages," the result, as expressed in the product of the plant, is likely to be nothing more than average. There is a "best" material or a "best" part for each condition, but the best for one use may very well be the worst for another. Consequently, when standardization in a plant begins to function to the extent that a new part or a material will not be purchased because "it isn't our standard," then design development and progress are likely to reach a low ebb.

Standardization, generally speaking, is a worthy aim. Many companies could do more than they are doing in the interests of economy by reducing the number of varieties of products and parts. But what is medicine in reasonable quantities may be poison in large doses. Instances might be cited where standardization has had deadening effects. Real progress in product improvement cannot be had unless the engineer is free to use the best of the new things being offered, and unless he keeps abreast of the development in fields related to his own.

▼

New Designs for Old

EVERY product engineer can profit from a course in history—in the history of product inventions. The engineer who thinks today that he has designed a marvelous product, and expects the public to share his enthusiasm and hasten to buy it, can profitably stop to ponder over the experiences of other inventors and the history of the development of other products. Such a course cannot but spur him to further redesign if he is a real development engineer.

Take the telegraph as an example. In 1753, Charles Morrison, a Scot, proposed to send messages by electric impulses, and he worked out a code of strokes and pauses on a bell. Then Sir Francis Ronald built a telegraph instrument using a pith ball actuated by a charge of static electricity sent along a wire. But it was not until eighty years later that Morse perfected the commercial electro-magnetic telegraph! Why? Because one necessary element was missing all the time—a method of applying a continuous current of electricity!

The airplane was "invented" in 1831, but it lacked an engine. Langley actually flew a model plane in 1893, but it lacked light motive power and a means of taking off. So it goes with the history of most products. Let those who think that their product of 1931 is the "best" look to what is lacking! There is probably at least one thing needed to give it that additional public appeal that means increased sales. It is the function of the product development engineers to find those points by a study of consumers' needs, and then sales will naturally follow.

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WHAT'S GOING ON—

The Month In Product Design

MANY continuous automatic canning machines were displayed at the Chicago convention of the National Canners' Association, evidence that automatic equipment is most economical even when the time of operation is but a few weeks of the year. Several machines developed to handle tomato and kraut juices required special materials because of the corrosive action of these juices. One machine uses chromium-plated bronze pistons and cast Monel metal cylinders to prevent electrolytic deposition of the bronze on the Monel in the presence of kraut juice. Glass-lined steel is now being used in an applesauce-making machine. Conveying of the material through the cooking chamber is by a Monel metal screw conveyor mounted on bronze-bushed Monel bearings. Faster speeds were evident in several types of equipment. One can-making machine rolls, seams, and solders 300 flat blanks per min.; another labels 500 cans per min., yet another halves 240 pears per min. Electrical cut-out devices on the labelling machine prevent failure. Rubber and fabric belts, wood and metal slats, chain, bucket, and metal mat types of conveyors are used. Most motor drives are roller chains; V-belts and silent chains following. A manufacturer of corn-huskers made a comparison of the new and old types, the former with cut herringbone gears, roller chain drive, friction clutch, and Alemite fittings; the latter with cast gears, malleable chain, tight-and-loose pulleys, and grease cups. Roller bearings are displacing sleeve bearings to some extent for high-speed shafts.

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REVOLVING POWER SHOVELS with 1-yd. capacity are being manufactured by the Keystone Driller Company. This is the first successful revolving skimmer-pullscoop machine, according to *Engineering News-Record*. A large roller path, 71 in. in diameter, with hold-down shoes tying the upper structure to the crawlers, gives necessary stability for control of the skimmer bucket in grading streets. The skimmer-ditcher boom weighs only 2,500 lb., and the bucket about the same, thus keeping the total boom and bucket load down and shortening the tail swing to 8½ ft. while increasing available pay load.

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ANTON FLETTNER, developer of the rotor ship which operates on the principle of a large cylinder revolving about a mast and using wind power much as does an ordinary sail, has introduced in Germany a motor vehicle which has a steering gear operating on the rotor principle. Instead of having a rigid chassis, it has an interacting double chassis, a large one on which the weight of passengers or freight rests, and a smaller one carrying motor and driver. Flettner claims steering requires only $\frac{1}{7}$ to $\frac{1}{10}$ the power required in ordinary gearing.

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OUTBOARD MOTOR-BOAT DRIVES designed by Joseph Van Blerck incorporate an unusual variety of materials. All castings are aluminum alloys, with drives of bronze. Alloy steel triple-roller chain drives the Everdur propeller shaft. The upper drive shaft is of alloy steel. A flexible Thermoid coupling avoids misalignment in the motor connection, and four double-row, heavy-duty ball bearings are incorporated.

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SILENT CHAIN transfer drives for motorboats being marketed by the Morse Chain Company are attached to the engines by two universal joints, one on each end of the shaft. The propeller is driven by a rigid shaft, protected against thrust by ball bearings. The drive chain is of the multiple-link type, of alloy steel similar to that in automotive timing installations. Chain and bearings run in oil. The drive will transmit 40 hp. at 3,000 r.p.m.

ADDITIONAL Miller Udezine units include clocks, lighters, humidors, bookends, and ashtrays, interchangeable to produce desired lamp fixtures

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A Glance Over the Pages—

1. *How does the magnitude of residual stresses vary with the size of a weld?* p. 117
2. *What is meant by "parison" in glass blowing?* p. 103
3. *What are the trends in canning machinery design?* p. 130
4. *Are aluminum dyed oxide coatings resistant to weathering?* p. 109
5. *What new materials are used in motion picture equipment?* p. 98
6. *How are rayon fibers spun into threads?* p. 114
7. *What, besides a ball, "rolls like a ball"?* p. 127
8. *Can the rotor principle be applied to automobiles?* p. 130
9. *Who is George Mead, Jr.?* p. 132
10. *How are semi-elliptic springs designed?* p. 143

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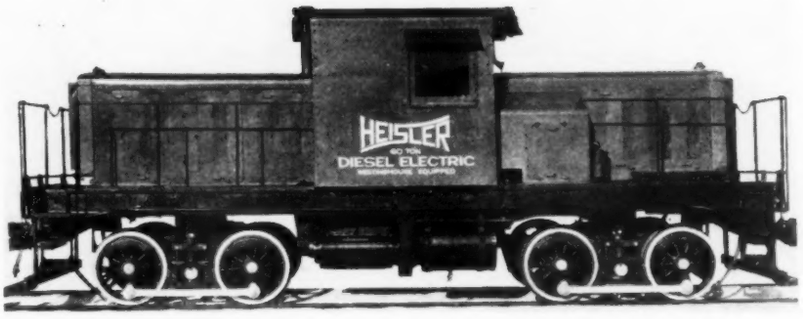
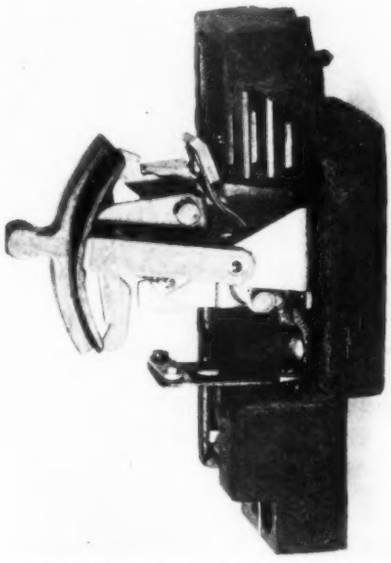


MOST POWERFUL of its size, this 60-ton oil-electric locomotive is designed for high power at switching speeds. The cast-steel frame carries two 180-hp. Buda Diesels driving two Westinghouse D.C. generators which supply current to two traction motors, driving one axle of each truck through bevel gears



DESIGNED to supplant house fuses, these 15-amp. Westinghouse circuit breakers are combinations of quick make-and-break switches and over-current protective devices

SMALL NEGATIVES—less than a half inch square—can be enlarged into perfect photographic prints 48 times their size by a new process invented by Dr. Miller R. Hutchinson, a possible complete camera redesign influence on the motion picture and photographic industries. Dr. Hutchinson's process consists in treating the film with a chemical solution after exposure to flatten the small scales of silver nitrate and other sensitizers which distort photographed details upon enlargement. Following treatment, sensitizers are made solid by the hypo bath in the usual way.

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ACCURATE horizontal drilling under a street or highway is accomplished by the "Hydrauger," which utilizes an Ingersoll-Rand air motor for motive power. The unit uses running water, passing through the boring bars and issuing in twin streams at the auger, to wash borings back and act as a lubricant. Feed is accomplished by a reversible ratchet which is a simple long-lever pawl and square-tooth rack on an angle-iron frame. A swivel is furnished for use with the ratchet in pulling in pipe or cable through the bored hole. Setting is done by "aiming" the Hydrauger at a target, and holes come out within 2 or 3 in. in 40 ft., on the average.

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AUTOMATIC TIMING SWITCHES, made by M. H. Rhodes, Inc., resemble the usual home flush-type wall electric switches, but have an additional toggle and indicator. By switching the toggle a given number of times, the time element in the switch receptacle is set to open the circuit at the expiration of the predetermined period. Three types are manufactured, seconds, minutes, or hours. The switch may also be used as a conventional lever switch, simply by throwing the toggle to the "off" position. It eliminates the necessity for three-way wire systems for remote control.

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ALL-WEATHER SEXTANTS seem possible with the invention of a preliminary instrument by Paul H. Macneil, which was successfully tested on the *Mauretania*. The device consists of two instruments, one the sextant, the other an amplifier. A special reflector concentrates the invisible rays and focuses them on an infra-red ray detector so designed and screened as to detect only the longer reradiated wavelengths. From this detector, flexible leads carry the electrical current to the amplifier, which after amplification is returned to the sextant indicating instrument. The sextant is used in the ordinary way, except that a maximum reading on the indicating meter is viewed instead of the sun's image. To increase the accuracy of the focus of the reflector the rays are required to pass through a diaphragm having an aperture of about one millimeter. Thus arranged, the accuracy obtained under ideal conditions is twenty seconds of latitude. The reading of angularity is done on the sextant in the usual way.

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GREIST hospital lamps utilize an unusual wall bracket which permits the lamp to be inverted to give indirect light, to be set for direct lighting as desired, or to be removed instantly from the bracket for use as an examining lamp. The bracket comprises two pairs of spring fingers which grip just above and just below the handle.

THE new Navy folding plane, which, with wings folded, will fit a torpedo tube. Built by Loening, it is all-metal and is assembled with cotter pins in foldable parts

COMBINATION electric ranges, cupboards, and kitchen tables, designed to "take the walking out of cooking," have been announced by the Estate Stove Company, according to *Electrical Merchandising*. Four heating elements are mounted at the left of the flat table-like top, the remainder being available for table space. The backboard carries a rack for salt and pepper shakers and an electric clock which also acts as an oven time control. A 2,000-watt broiler is located beneath the cooking top. It slides on roller bearings, as do the drawers and oven racks, and is so arranged that by turning the drawer handle the broiler is raised or lowered to suit various cuts of meat. An oven is located beside the broiler, all parts being easily removable for cleaning. Two lower drawers are designed to hold kitchen utensils and cutlery, racks being provided. The finish is full vitreous enamel in solid green, ivory, or white, that being the order of preference expressed in a survey. Insulation is rock wool. Legs, adjustable for height, are of stainless steel, as is the top. A single switch controls both broiler and oven.

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DYNAMIC BALANCING machines of the Tinius Olsen Testing Machine Company are of the semi-automatic, electric-spark type, accurate to 0.05 oz.-in., thus presenting a production-type machine with laboratory accuracy. They employ a "phase angle" shifter coupled to the driveshaft for the work. The entire drive head, work supports, and work are carried on a vibrating frame which is sensitively and flexibly supported on four pins of small diameter. Vibration of this group causes sparking on a circular contact plate, which is graduated in degrees to show the angle of unbalance. Amount of unbalance is shown mechanically by a weight moving on a scale.

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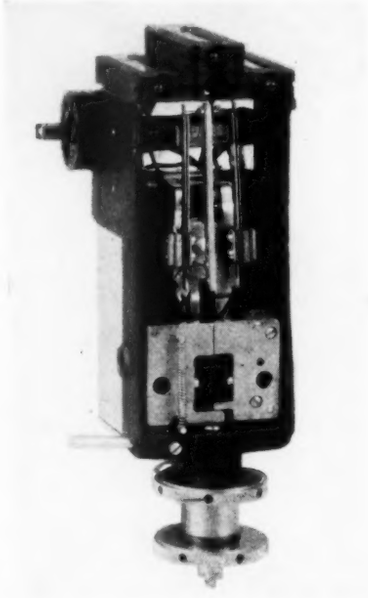
CYLINDER-BLOCK cleaning machines developed by N. Ransohoff, Inc., have two chambers, the first containing nozzles set to force Oleum spirits into all holes and pockets of the casting, and the second containing air jets similarly located, according to *American Machinist*. A lever arrangement permits the resetting of the nozzles for one other type of cylinder block, permitting the use of one unit for two designs of block without alteration of equipment. A distillation system is provided to clean the spirits, which are circulated at 35 lb. per sq. in. centrifugally.



SHEFFIELD electric gage interior. The gage has accuracy to 0.00001 in., with contact points adjustable from 0.00002 to 0.002 in. tolerance. Colored lights indicate the gaging

DESIGNED to compete with the private automobile in comfort, appearance, and speed, the new 4-wheel street railway car developed by J. R. Blackhall is a deliberate departure from conventional street-car design. The underframe is entirely of heat-treated aluminum alloy extruded and rolled sections; sides are rolled and window frames extruded aluminum; the ceiling is part-rolled aluminum sheet carried around the vestibule in the form of an ellipsoid; and the ends are replaceable aluminum castings. The result is a 17,500-lb. car utilizing 6,876 lb. of aluminum to save 12,324 lb. The car employs dynamic braking and two alternative systems of friction braking, using brake shoes on disks mounted on the motor shaft, also connections to allow "plugging the motors" for severe braking. Brakes and doors operate hydraulically for lessened noise and more positive action. The gear pump for this work weighs only a few pounds and has but two moving parts, the complete system, with all parts, weighing less than 150 lb. Further noise reduction is effected by stopping wheel resonance, inserting rubber pads between axles and frame, installing Masury shock insulators on the spring ends, and insulating the floor, trolley base, and motor supports. Heating is provided by the rheostatic losses during periods of acceleration or resistance and dynamic braking. The floor level is but 24 in. from the street, and the car has an exceedingly comfortable and pleasing appearance. Body lines are carried entirely around the car without a break, a continuous skirt is brought down to the lower step level, chromium-finish bumpers are applied, and the entire car is Ducoed with Abbott gray as the principal body color and Tonowanda green as the relief. The car seats 40 passengers in semi-bucket leather seats.

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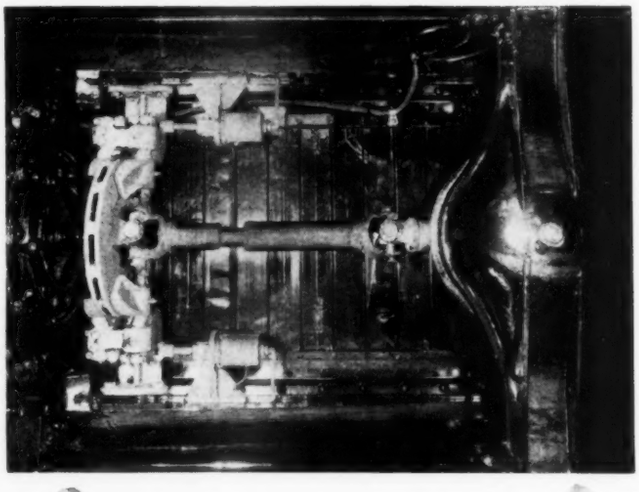

BLACKHALL chassis truck consists of Timken semi-floating axles with centrally located worm gear, 22-in. spun cast steel wheels, and side frames designed as trusses with underslung compression members

AN UNDER VIEW of the Blackhall car, showing the hydraulic brake system, the brake disk mounted on the propeller shaft, the brake shoes, and the semi-floating axle

SYNTHETIC SPEECH has been produced in England by E. A. Humphries. Words traced on cardboard were photographed on a sound film, then projected in the ordinary way. The words are assembled from sounds analyzed from sound tracks of human voices.

Standards & Specifications

PROPOSED Federal Specifications issued to representative manufacturers for comment and criticism during the past month include the following: No. 376 on Varnish Shellac; No. 476 on Dry Chrome Yellow, either paste-in-japan or paste-in-oil; an unnumbered specification for Axes; No. 104a on Spiral, Gland, Low-Pressure Packing; No. 110a on Rubber, Cloth-Insertion Packing; No. 101c on Flax Packing; No. 486 on Hard Sheet Fiber Packing; No. 487 on Asbestos Rope and Wick Packing; No. 242a on Wrought-Iron Welded, Black and Galvanized, Pipe; No. 590 for Illustrating Board; No. 594 for Detail-Drawing Paper; No. 469 for Structural Steel and Rivet Steel for Ships Other Than Naval Vessels; No. 117 for Pig Lead; No. 283 for Putty; No. 10b for Ready-Mix and Semi-paste, Olive-drab Paint and No. 4b for Raw Linseed Oil.

Simplified Practice Recommendation R118-30 on Abrasive Grain Sizes has received sufficient acceptance from industry to insure general adoption of the program. It will be considered effective forthwith. Simplified Practice Recommendation No. 63 on Metal Spools will be further revised by a sub-committee which will submit its first progress report on or about March 1.

Standardization of equipment used by American foundries has been decided upon by the American Standards Association. Under the technical leadership of the A.S.M.E. and A.S.A., the project will be given to a working committee.

The Engineering Foundation will co-operate on a two-year investigation of the effects of high temperatures on metals by the A.S.M.E., and the A.S.T.M. The Foundation will also aid the A.I.E.E. in an investigation of pure iron electrodes. Other research enterprises include those on alloys of iron, and fundamental properties of dielectrics. Six zinc-coating A.S.T.M. specifications have been advanced to standards.

First distilled chromium, produced at the Westinghouse Laboratories. It was made in high vacuum at a temperature of 4,250 deg. F.

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Professional Societies Offer Job Services

The American Trade Association Executives and the National Engineering Societies have rosters of a number of well qualified engineers, business executives, and technicians, many of them without a position because of the present economic condition. Information regarding the executives available may be obtained from the American Trade Association Executives, 45 E. 17th St., New York, N. Y. Information on professional engineers or technicians may be obtained from Walter V. Brown, Engineering Societies Bldg., 31 W. 39th St., New York, N. Y. The work is a free contribution to industry by these organizations.

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Revolving wheels similar to an automobile speedometer form the basis for the automatic telephone call indicator invented by William Greenberg

News of the Metal Market

ALL common utility metals experienced continued price declines throughout the year 1930, according to the annual review number of *Engineering and Mining Journal*. Nor does it look like rising prices in 1931, for, continues the same authority, "the world seems to be suffering from a glut of raw materials." Copper created the sensation of the year, and no one dares to predict whether the present lows of around 10c. are permanent or whether something close to previous prices will be resumed when prosperity returns. During 1931, Soviet Russia is expected to surpass all other European countries in copper production, and this may have effect on the world markets.

NICKEL markets have been effected by copper because the nickel ores of Canada are largely copper ores, but the tremendous increase in industrial uses for nickel and nickel alloys will steady prices of this metal once business activity is resumed. Nickel was selling, in mid-February, for 36c. per lb. in shot and ingot forms.

ALUMINUM found many new applications during the past year, especially in transportation equipment where light weight is of increasing importance. Present prices range about 23c. per lb. with prospects that both production and consumption will increase with nothing erratic in view in the market.

BERYLLIUM continues to be widely talked of as a new light metal, but no real consumption can be anticipated until the present prices of about $145 a lb. can be cut by improved production methods. *Mining Journal* states that "probably no light metal since the commercialization of aluminum holds such high future promise as does beryllium." But reported ore deposits have turned out to be low in metal and extraction is complicated.

LEAD prices in February were about 4.8c., as compared with 6.25c. a year ago. Russia will be a factor in lead production from now on, but not sufficiently to effect the American home market. Consumption of lead, tin, and zinc is naturally seriously affected by reduced machinery production because of the use in bearing metals and non-ferrous alloys. Zinc was selling in February at 4.03, as compared with 6.5 last year.

IN THE SPOTLIGHT—

CLIFFORD F. MESSINGER has been elected president and general manager of the Chain Belt Company, Milwaukee. He was previous vice-president and general manager and succeeds C. R. MESSINGER as president.

DR. LAWRENCE W. BASS has resigned as executive assistant director of the Mellon Institute of Industrial Research, Pittsburgh. DR. LEONARD H. CRETCHER, head of the Department of Research in Pure Chemistry since 1926, has been appointed to an assistant directorship and will be assisted by DR. WILLIAM L. NELSON.

F. H. BIGGERT, JR., vice-president of the United Engineering & Foundry Company, Pittsburgh, Pa., has been appointed a member of the A.S.M.E. Research Committee for the term 1930-35. Mr. Biggert takes the place made vacant by the retirement of ROBERT L. STREETOR, vice-president of the U. S. Aluminum Company, Pittsburgh, Pa.

ARCHIBALD BLACK has resigned as president of Black & Bigelow, Inc., New York City, and been succeeded by A. A. BIGELOW, formerly vice-president. Mr. Black will, however, continue as consulting engineer of the corporation. The firm name has been changed to A. A. Bigelow & Company, Inc.

GEORGE J. MEAD, vice-president for five years of the Pratt & Whitney Aircraft Company, Hartford, Conn., has been elected vice-president of the United Aircraft & Transport Corporation. He will have charge of the newly organized experimental and research division, with headquarters at the company offices at East Hartford.

ROBERT DEFORREST BOOMER, who for the last 12 years has been identified with E. H. Rollins & Sons, New York, was elected a director of the J. G. White Engineering Corporation of the same city on Jan. 27.

HOWARD BUTT has been made Manager of the Engineering and Export Departments of the William Powell Company, Cincinnati. Mr. Butt's headquarters are at 50 Church St., New York, N. Y.

ERNEST ELMO CALKINS, president of Calkins & Holden, New York, will speak on "Consumer Engineering" at the April 16 meeting of the Management Division, Metropolitan Section, A.S.M.E.

MICHAEL REISNER, chief engineer of the Cincinnati works, Worthington Pump & Machinery Corporation, Harrison, N. J., will henceforth devote his time to the design and development of new products. A. V. SAHAROFF will become works engineer and take over Mr. Reisner's operating engineering work. Mr. Reisner has been with the organization since 1892. Mr. Saharoff since 1919, lately as general superintendent, where R. L. RICKWOOD will succeed him.

DR. FRANK CONRAD, assistant chief engineer of the Westinghouse Electric & Manufacturing Company, received the 1930 Edison medal of the A.I.E.E., for outstanding achievements in the field of electricity.

GLENN CURTISS, CHANCE VOUGHT and DANIEL GUGGENHEIM will be commemorated in an Aeronautic Meeting to be held Feb. 25 at the Engineering Societies Bldg., in New York City, under the sponsorship of the A.S.M.E. Chamber of Commerce, National Aeronautic Association, A.I.E.E., A.I.M.E., A.S.C.E., and S.A.E.

Clifford F. Messinger

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George J. Mead, Jr.

●

Michael Reisner

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LOUIS S. CATES, president of the Phelps Dodge Corporation, has been elected president of the American Institute of Mining & Metallurgical Engineers. T. M. WELD has been elected vice-president, W. D. B. MOTTER, secretary and treasurer. G. TEMPLE BRIDGMAN was the retiring president. Counselors elected included W. R. INGALLS, LUCIUS W. MAYER, R. A. F. PENROSE, JR., GEORGE E. COLLINS, W. C. BROWNING, and F. A. THOMSON.

W. T. DONKIN, engineer of the Cleveland (Ohio) Wire Spring Company, has returned to active duty after a protracted illness.

A. DUPERRON, chief engineer of the Montreal Tramways Commission, has been elected chairman of the Montreal branch of the Engineering Institute of Canada.

J. FRANK DURYEA, vice-president of the Stevens-Duryea Company, Chicopee Falls, Mass., has retired.

GEORGE EASTMAN, president of the Eastman Kodak Company of Rochester, N. Y., has been made an officer of the French Legion of Honor and has been made a Knight Commander of Wasa by the King of Sweden.

FRED W. HERLIHY, formerly chief automotive engineer at the New York headquarters of the Shell Eastern Petroleum Products, Inc., Boston, has been appointed sales manager of the New England district.

EDWARD M. HULETT, veteran engineer of the General Electric Company, who designed the control apparatus and switchboards for the Panama Canal locks, was recently tendered an honorary banquet on the eve of his retirement.

B. JARDINE has been named chief engineer of the Wilcox-Rich Corporation, Detroit and Jackson, Mich.

CHARLES L. LAWRANCE, formerly president of the Wright Aeronautical Corporation and designer of the Wright Whirlwind engine, was elected president of the Aeronautical Chamber of Commerce for 1931, to succeed FREDERICK B. RENTSCHLER, president of the United Aircraft & Transport Corporation, head of the Chamber for the past two years. Mr. Lawrance is now working on the development of an airplane engine which will burn a low grade fuel oil instead of gasoline.

W. LAURENCE LEPAGE has become chief engineer for the Kellett Aircraft Corporation, Philadelphia.

PAUL D. MERICA of the International Nickel Company, will speak on "Non-Ferrous Metals" at the March 5 meeting of the Metropolitan Section, A.S.T.M. J. A. CAPP of the General Electric Company will discuss "Electrical Materials."

WILLIAM H. PIERCE received the James Douglas medal of the A.I.M.E. at the recent annual meeting, for his numerous designs and improvements of devices and machinery for smelting, refining, and rolling copper.

DR. M. LUCKIESH, director of the Lighting Research Laboratory, General Electric Company, spoke on "Color in the Work World" at the Feb. 10-11 meetings of the Metropolitan section, A.S.M.E., which were held in co-operation with the Museum of Science in Industry in the City of New York. All meetings were held in the Engineering Societies Auditorium, 29 W. 39th St.

R. W. OWENS, manager of Industrial Motor Engineering for the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been made general manager of Industrial Engineering and will represent S. M. KINTNER, assistant vice-president, in his work with several departments. THOMAS F. PERKINS, formerly manager of Supply Engineering and consulting engineer, has been made general manager of Distribution Engineering and will represent Mr. Kintner in his work with another group of departments. W. M. MCCONAHEY has been appointed consulting engineer with headquarters in the Transformer Engineering Department of the Sharon (Pa.) Works. H. V. PUTNAM succeeds Mr. McConahey as manager of the Transformer Engineering Department. M. S. HANCOCK has been appointed assistant manager of the Industrial Motor Engineering Department, and R. E. MARBURY has been made assistant manager of the Supply Engineering Department.

JOHN REED has been appointed superintendent of the Tiffin (Ohio) plant of the Standard Sanitary Manufacturing Company, Pittsburgh, to succeed GEORGE SWINNERTON, who has been made assistant engineer of the Trenton, N. J., plant.

H. T. SCOTT, formerly chief engineer of the Toledo General Manufacturing Company, has become chief engineer of the American Paper Bottle Company, 931 Brown Avenue, Toledo, Ohio.

F. B. SELENSKY, formerly chief draftsman for the Climax Engineering Company, Clinton, Iowa, has accepted a position in the engineering department of the John Deere Tractor Company, Waterloo, Iowa.

ALLEN SEYMOUR of the Norton Company, Worcester, Mass., spoke on "New Developments in the Abrasive Industry" at the Feb. 10 meeting of the Hartford chapter, A.S.S.T.

DR. GEORGE K. BURGESS, chief of the staff of the U. S. Bureau of Standards, will explain in detail the work and duties of his branch of the Federal Government before the Akron-Canton local section of the A.S.M.E., Feb. 27.

DAVID SICKLESTEEL, formerly chief engineer with the Detroit Gear & Machine Company, has joined the engineering staff of the Muncie (Ind.) Products Division of the General Motors Corporation.

O. D. TREIBER, previously president and chief engineer of the Treiber Diesel Engine Corporation, Camden, N. J., has become chief engineer of the Diesel division, Hercules Motors Corporation, Canton, Ohio.

G. T. SNYDER, chief engineer of the National Tube Company, Lorain, Ohio, has been transferred to the Engineering Department at Pittsburgh.

RAYCROFT WALSH, formerly vice-president and general manager of the Hamilton Standard Propeller Corporation, Homestead, Pa., has been elected president to succeed E. E. WILSON, who has resigned to devote himself to the Sikorsky Aviation Corporation, of which he is president.

F. G. WHITTINGTON as been appointed chief engineer of A. Schrader's Son, Inc., Brooklyn, N. Y.

ROY WILKINS has been appointed vice-president in charge of engineering of the Pacific Electric Manufacturing Company, San Francisco.

ROBERT F. WINTER, formerly production manager with the Freeman Motor Company, Detroit, has become an experimental engineer with the Brunswick Radio Corporation, Muskegon, Mich.

AUGUSTUS WOOD, formerly chief engineer and works manager of the Niles Tool Works, Hamilton, Ohio, until 1920, has returned to the company. During his absence from the Niles company, he has been works manager at the Putnam Machine Company, consulting engineer for Manning, Maxwell & Moore, and more recently consulting engineer for the Consolidated Machine Tool Corporation. Mr. Wood's new connection with the Niles company is as a consulting engineer.

R. W. Owens

W. M. McConahey

STEPHEN J. ZAND, formerly aeronautical engineer with the Taylor Instrument Companies, Rochester, N. Y., has taken a similar position with the Pioneer Instrument Company, Brooklyn, N. Y.

Obituaries

SIR CHARLES A. PARSONS, 76, inventor of the modern steam turbine and one of the world's foremost shipping engineers, died at sea, Feb. 12. He was a developer of the principle of "Pressure-Compounding," and had recently completed the design of the engines of the "Acheron," new British torpedo-boat destroyer which is 10 to 15 per cent more economical than other ships of her size.

GEORGE A. WARD, 66, designing engineer of the Wilputte Coke Oven Corporation, New York City, died Jan. 19 of complications following an operation.

PELLE ANDERSON, engineer in charge of the Steam Engine Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., died Jan. 10. He had been associated with the company for 27 years.

WALTER PLATT HATCH, 78, who held many patents for inventions, notably in connection with typewriters, died in East Orange, N. J., on Jan. 19. He helped form the Elliott & Hatch Book Typewriter Company, which was later merged in the Underwood-Elliott-Fisher Company.

EDWARD GAGEL, 73, chief engineer of the New Haven Railroad for the last 24 years, died in West Haven, Conn., Feb. 11, of heart disease after an illness of several months. He retired two years ago.

EDWARD W. HEATH, 42, designer and manufacturer of light low-cost airplanes, crashed to his death in Chicago, Feb. 1. Mr. Heath was president of the Heath Airplane Company and had been flying for more than 20 years.

WILLIAM J. KIMMEL, 25, credited with the development of the first practical A.C. radio tube and engineer with the Westinghouse Electric & Manufacturing Company, was killed Feb. 9, during a research experiment with high-tension electricity.

W. H. BARTRAM, assistant engineer of the Open-Hearth Plant of the Republic Steel Corporation, Youngstown, Ohio, died Feb. 6, in an unsuccessful effort to save the life of John Jenkins, a repairman, in a gas-filled pit.

ARCHIBALD BANNATYNE, 78, originator of the dollar watch which later became the Ingersoll, at one time master mechanic of the Waterbury Clock Company, died at Waterbury, Jan. 29.

ALMON E. NORRIS, chief engineer of the Mead-Morrison Manufacturing Company for 26 years and with the company and its subsidiaries for 35 years, died suddenly at his home in Brookline, Mass., Jan. 15. During his career he designed and invented many materials-handling units.

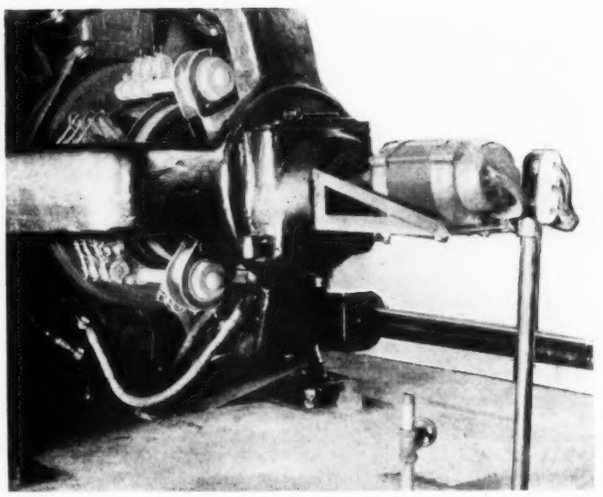
NEW MATERIALS AND PARTS AND ENGINEERING ✦ EQUIPMENT ✦

"Selsyn" Speed Controls

SYNCHRONIZED operating speeds of two or more non-synchronous motors can now be maintained by means of a control system announced by the General Electric Company, Schenectady, N. Y. This system, in which "Selsyns" (small self-synchronizing motors) play a fundamental part, is of advantage in industrial applications where synchronous operation of different machines or devices is essential, particularly on various process equipment.

The first application of this control system has been made at the Keystone Portland Cement Company's plant at Bath, Pa. Its duty is to maintain the feed of raw material exactly proportional to the speed of the kiln. This is accomplished by holding the speed of the feeder motor in synchronism with the speed of the kiln motor.

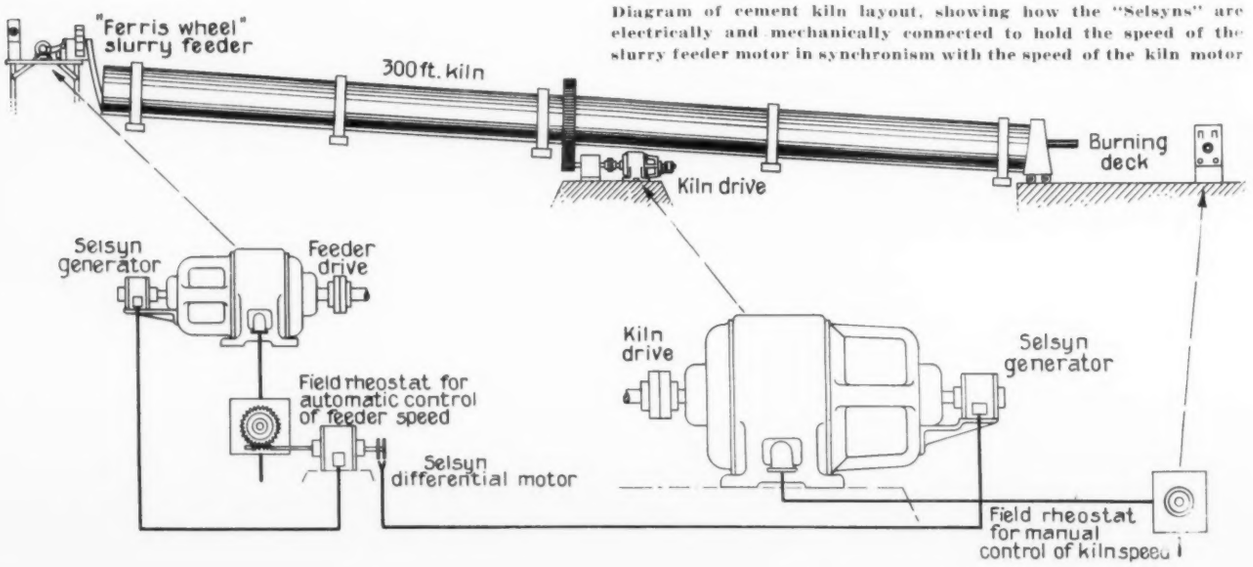
The kiln and feeder driving motors have adjustable speeds to operate over a wide range. Speed changes of the kiln driving motor are controlled by the kiln attendant. "Selsyn" generators are mechanically connected to the shafts of the motors driving the kiln and the slurry feeding mechanism. Normally the generators are in synchronism. A Selsyn differential motor has its stator electrically connected to one generator and its rotor to the other. When the generators are in synchronism, the Selsyn motor has no tendency to rotate. Any deviation in speeds between the two generators will cause the differential motor to rotate forward or reverse, depending on which generator is ahead, the motor speed being equal to the difference between the generator speeds. The Selsyn motor is geared to a cam that actuates a carbon-pile resistor connected in the field circuit of the feed motor. The resistance of the carbon pile changes with pressure and thus changes the speed of the slurry feed motor and again establishes a balanced condition.



"Selsyn" generator attached to the shaft of one of the driving motors of a cement kiln layout

A single manual control equipment thus governs the two d.c. motors. Adjustments in speed of the kiln drive

Diagram of cement kiln layout, showing how the "Selsyns" are electrically and mechanically connected to hold the speed of the slurry feeder motor in synchronism with the speed of the kiln motor

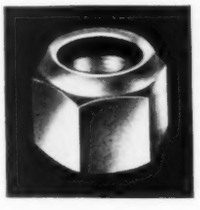


motor are immediately reflected by exactly proportional changes in speed of the motor driving the feeding mechanism. This system of control, by the addition of simple gearing to drive one generator, can also be used to maintain predetermined proportional speed relations between two or more mechanisms driven by non-synchronous electric motors of widely different speeds.

"Elastic" Stop Nuts

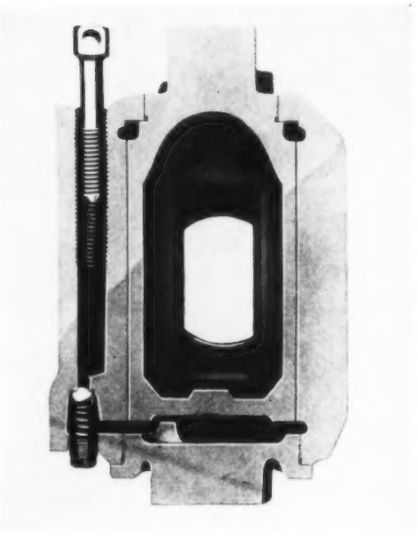
RESISTANCE of the fiber ring in the "Elastic" stop nut to passage of a screw causes a constant pressing together of the thread flanks. Therefore, a good electrical connection can be obtained with the use of this device or it may be used on screws subject to vibration at loads up to the capacity of the fiber. For example, the allowable end pressure amounts to between 500 and 700 lb. on a $\frac{5}{8}$-in. bolt. This force is sufficient to maintain an undisturbed flow of electric current.

"Elastic" stop nuts are manufactured by the AGA Company, Elizabeth, N. J., in sizes from No. 4-48 up to $2\frac{1}{2}$ in. They are manufactured in such materials as steel, duralumin, brass, bronze, Monel metal, and other metals. They are made in standard thread systems and are capable of repeated removal without injury to the threads or the nut. They are adjustable to any position along the screw. Besides their use in the electrical connections, they can be employed on spring mountings, on rubber-insulated and cushion mountings, aircraft applications, impeller and propeller shafts, and flexible couplings.



"A.C.F." Milliken Valves

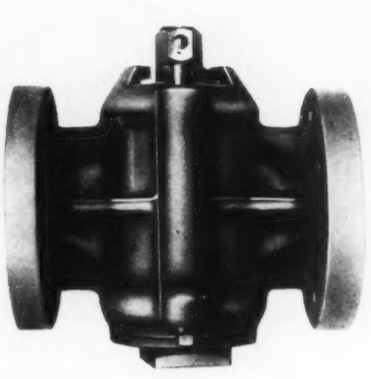
FEW parts in the "A.C.F." Milliken valves, placed on the market by the American Car & Foundry Company, Valve Division, 30 Church St., New York, N. Y., permit low first cost and low maintenance cost. The valve has a solid head, thereby avoiding the use of glands, gland bolts, bonnets or stuffing boxes, and employs



Cross-section of "A.C.F." Milliken Valve, showing that the plug is not raised away from the seat

no packing or gaskets. It has the same face-to-face dimensions as standard flanged gate valves and opens and closes with a quarter turn, having a positive stop. All moving parts are completely lubricated. The valve is offered for use on gasoline, oil, water, steam, boiler blow-off, air, vacuum, gas or chemical lines, and can be furnished in sizes from 1 to 8 in. and for pressures of 125, 175, and 250 lb. per sq.in., and also in the Venturi type for 500 lb. per sq.in., both in screwed and flanged models. It is also available in aluminum and acid-resisting bronze in sizes up to 3 in., and also in the form of special valves for handling to 66 deg. Bé. sulphuric acid, as well as in other metals to suit various purposes.

In this type of valve there are no seats to cut, and hence it is not necessary to take a valve off the line for reseating. It also occupies less headroom than the standard gate valve.



"A.C.F." Milliken Valve, which has small headroom, and which has the standard flange-to-flange distance of a gate valve

The plug is not raised away from the seat and consequently there is no opening formed for foreign matter to get in and cut the seat. The plug is the only moving part and it is completely lubricated.

"Chromaloid" Satin-Finish Sheet

CHROMIUM is bonded to the zinc base of satin-finish "Chromaloid" produced by the American Nickeloid Company, Peru, Illinois. This satin chromium finish can be made to order on other base metals, such as brass, copper and steel sheets and coils. The satin finish can be supplied on one or two sides and is stainless, non-tarnishing, non-rusting, and easily worked. The cost averages about half that of corrosion-resistant alloys.

"Chromaloid" can be formed, double seamed, and bent back on itself both with and against the grain, without peeling of the plate, and requires no further polishing, plating or refinishing after the parts are fabricated. It can be soldered after removing the chromium with acid. It is made up in standard size sheets 36x84, 36x42, 18x42, 21x44, and 21x36 in. The maximum size sheet that can be made at present is 36x96 in. The material can also be supplied in coil form, the maximum width being 12 in. The thickness ranges from 0.008 to 0.070 in.

"Alectral" Aluminum Wire and Cable

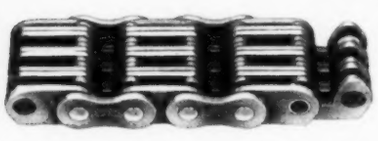
INSULATED aluminum wires and cables and necessary fittings have been placed on the market under the trade name of "Alectral" by the General Cable Corporation, 420 Lexington Ave., New York, N. Y. The conductivity of aluminum wire is 63 per cent of that of comparably drawn copper wire. It requires a cross-section in inverse ratio to the relative conductivity. An aluminum conductor must therefore have 59 per cent greater cross-section than copper of equivalent conductivity, or a diameter ratio of 1.26. Thus, for a given size of copper conductor, an aluminum conductor two A.W.G. sizes larger is substituted. Of course, the lighter weight even with insulation is the prime factor.

NEW MATERIALS AND PARTS

Whitney Reversible Side-Guide Silent Chain

A REVERSIBLE silent chain that allows the direction of driving to be reversed and will drive on either or both faces has been placed on the market by the Whitney Manufacturing Company, Hartford, Conn. It is particularly adaptable to installations where lack of vibration is desirable; where it is desired to drive several shafts in different directions of rotation, or where it is necessary to install a chain take-up device to operate on the back of the chain.

The chain utilizes a double internal chain-link and sprocket-tooth engagement on either face on one row of links across the chain, with the supporting external engagement of the next row of links on either side of the internal contacting row. This construction gives joint load relieving features of the standard single-face, automotive, internal-engagement-type silent chain, supplemented by the rigidity and strength of the external method of chain-link and sprocket-



tooth engagement. The side-guide type of chain construction is used and only chains of an even number of pitches can be employed.

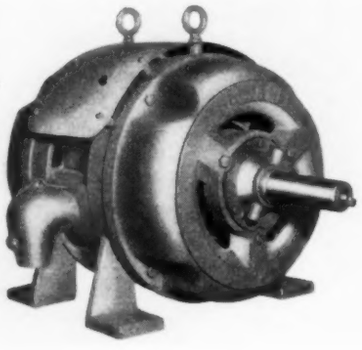
In selecting sprockets for use with the reversible chain, it is necessary to choose those with diameters that employ an even number of teeth when designed for the conventional single-faced chain, since every other tooth is removed in the reversible chain sprockets to permit the passage of the back of the reverse-face links in their travel over the sprockets.

"New Facila" Protractor Triangle

IMPROVEMENTS in the "New Facila" universal protractor triangle have been announced by E. S. Brown, Garrow St., Auburn, N. Y. The improved model is better safeguarded against displacement of the protractor by dropping the instrument. This is achieved by extending the protractor to form a part of the hinge for the swinging arm, and thus the protractor is self-centering at all times. Angular lines can be drawn either right- or left-hand, together with lines at right angles to them, and yet the instrument is available for drawing vertical lines without disturbing the angular setting.

Reliance Motors with Drip Covers

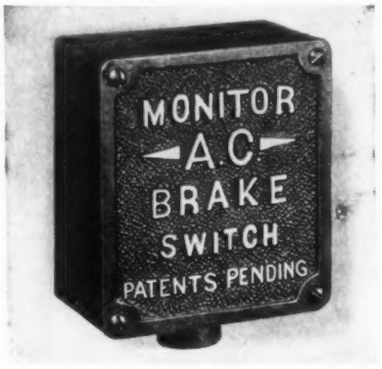
DRIP covers applicable to either a.c. or d.c. motors of its manufacture have been announced by The Reliance Electric & Engineering Company, 1042-1090 Ivanhoe Road, Cleveland,



Ohio. The covers are used to protect motors in bad locations from dripping water, acid, or other injurious solutions. Such covers have been found of aid in keeping the motors clean and lowering maintenance costs. They are made of heavy-gage sheet steel bolted to the frames in roof-like fashion, so that an opening is provided between the motor and cover to permit free circulation of air.

Monitor Slip Switch

BRAKING a.c. motors is the function of the slip switch announced by the Monitor Controller Company, Baltimore, Md. This switch is designed for use with a.c. controllers where reverse-torque or plug-reverse braking is employed, and where motors coming to rest can be allowed to start in the reverse direction before being disconnected from the line. The slip switch is attached to the motor end bell and is operated by a direct connection to the end of the motor shaft. The contact switch is operated by an arm connected to a friction ring mounted on an extension of the motor shaft. The friction

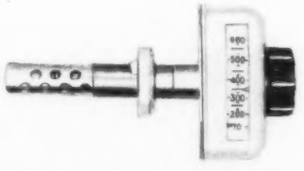


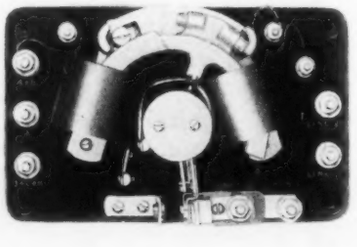
pressure obtained holds the contacts closed. Motion in the opposite direction opens the contacts. By this construction the motor is disconnected the moment it comes to rest and starts to reverse.

The slip switch is completely enclosed and is arranged for rigid- or flexible-conduit connection.

Cooper Oven Heat Control

HEAT control of industrial ovens to 600 deg. F. can be taken care of with the combined thermostat and circuit breaker announced by the Cooper Oven Thermometer Company, Pequabuck, Conn. The relay or circuit breaker is known as the "Reichold" relay and can be operated on either 25 or 60 cycles and on voltages between 95 and 130 volts. This is possible since the coils are not carrying current except during the time when





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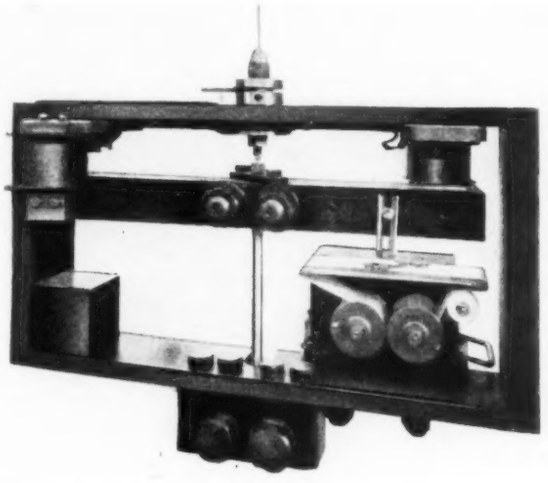
the thermostat is in action. No current is consumed by the relay except at the moment when the relay makes or breaks connection. Applied to an electric household range, it can be equipped with identical switches for ovens as well as plates. In other words, it is not necessary to have switches with so-called pilot contacts.

"Foeppl-Pertz" Damping Tester

FOR the determination of internal frictional losses of materials, the Southwark Foundry & Machine Company, Testing Equipment Division, Philadelphia, Pa., is announcing a "Foeppl-Pertz" damping tester weighing approximately 160 lb., and having over-all dimensions of 24x18x10 in. This damping tester is mounted on a frame hung from the ceiling on a wire about 10 ft. long. This unusual way of mounting the machine is one of the special features which provide the high accuracy needed in determining the small amounts of work absorbed by internal friction in the specimen. The test rod is placed centrally and clamped rigidly on its bottom into the frame by means of heavy screws and carries on its top an oscillating mass, which makes a reciprocating rotary movement about the axis of the specimen, twisting the same back and forth. A small pivot avoids any lateral movement, to give torsional stresses only.



"Foeppl-Pertz" Damping Tester for determining internal frictional losses of material

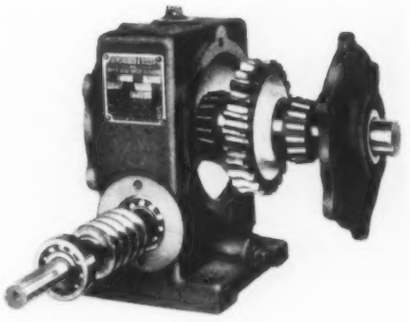
The test is started by twisting the mass to a desired amount and holding it in a twisted position by means of an adjustable electro-magnet. Upon breaking the electrical contact, free oscillation is produced. The stylograph attached to the mass at the lower right records a damped free vibration diagram on the chart moved by the clockwork. These curves are obtained in a few minutes and represent the damping characteristic of the material, which can be replotted in the form of diagrams, showing the amount of work absorbed in relation to the rate of stress.

"Stronger-Than-Steel" Aluminum-Bronze Die-Castings

FOR parts where high strength, resistance to corrosion, absence of aging changes, and elimination of machining costs are factors, the Aurora Metal Company, 614 West Park Ave., Aurora, Ill., is offering "Stronger-Than-Steel" aluminum-bronze die-castings. The aluminum-bronze used contains 89 per cent copper, 10 aluminum, and 1 iron. As cast under pressure, it has a tensile strength of 85,000 lb. per sq.in. and a hardness of 66 Rockwell B, or 140 Brinell. When heated to 1,700 deg. F. and quenched in water, the tensile strength is increased to 100,000 lb. and the hardness to 110 Rockwell B, or 260 Brinell. At 1,000 deg. F., the tensile strength is 19,000 lb. per sq.in.

Horsburgh & Scott Worm-Gear Speed Reducers

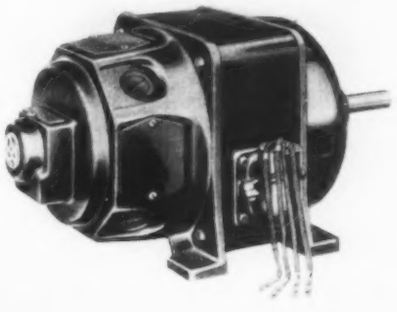
TWO small speed reducers of worm-gear design have been placed on the market by The Horsburgh & Scott Company, 5114 Hamilton Ave., N. E., Cleveland, Ohio. These reducers are designated as series WB-600 and WB-700 and deliver maximum torques on the gearshaft of 1,100 and 2,140 in.-lb., respectively. Both are available in ratios from $4\frac{1}{6}$ to 1 up to 60 to 1 and with wormshaft speeds from 300 to 3,000 r.p.m. Running at a wormshaft speed of 1,800 r.p.m. the 10 to 1 WB-600 reducer will have a horsepower rating of 2.1 and the WB-700 a rating of 2.6 hp.



As shown by the illustration, the worm shaft is mounted on ball bearings and the wheel shaft on roller bearings of the tapered variety. The worm is forged integral with the shaft and the threads are hardened, while the top, bottom and sides of threads are ground after hardening. The face of the solid bronze wormgear is extra wide. The housing is a gray-iron casting made in one piece, with the gear introduced through the side. Where it is desired to have the speed reducer and motor mounted together, bedplates of welded steel are supplied.

Robbins & Myers Box-Frame Motors

BOX-FRAME motors in sizes from $\frac{1}{2}$ to 3 hp. are available from Robbins & Myers, Inc., Springfield, Ohio, and Brantford, Ontario. They are compact, powerful, and have semi-enclosed end heads, as shown in the illustration. Mounting dimensions are the same as for repulsion induction, single-phase, polyphase, and d.c. types having similar ratings and speeds. An improved wool yarn bearing lubrication system is standard, but ball-bearing motors are built.



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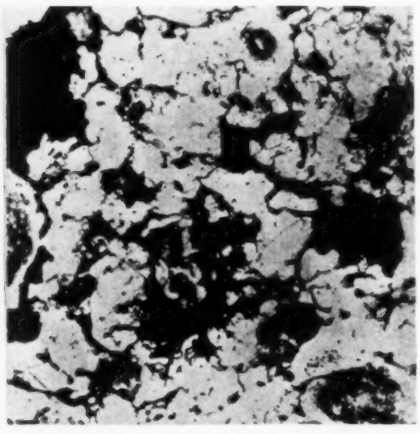
"Oilite" Bearing Material

HIGH oil content is the feature of the "Oilite" bearing material marketed by the Amplex Manufacturing Company, 7900 Joseph Campau Ave., Detroit, a division of the Chrysler Corporation. This material is an alloy of copper, tin and other metals. In manufacture this material is subjected to tremendous pressure, heat-treated to form a sponge, and then impregnated with hot oil in a vacuum. It absorbs up to 40 per cent of oil by volume.

"Oilite" has greater strength than



"Oilite" Bearing Material magnified 275 times. The dark areas are filled with oil

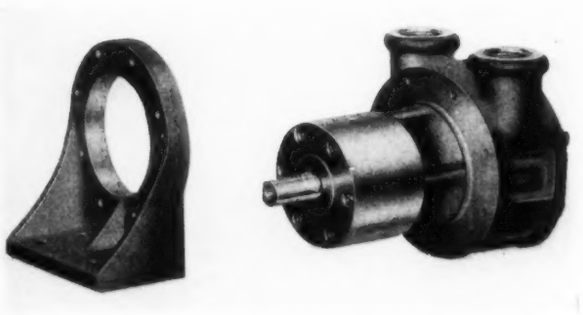
common in "self-oiling" bearing materials. Because of its high oil content, a hydraulic cushion exists that also permits bearing loads in excess of those carried by conventional bearing materials. It is claimed to be superior to high-grade cast bronze for applications where severe duty and high pressures are encountered. It imparts a high polish to shafts, instead of scoring them, and can be made to a high standard of accuracy.

Tuthill Model CP Oil Pumps

FOR hydraulic applications, but also suitable for handling lubricating liquids, the Tuthill Pump Company, Chicago, Ill., has announced a line of ball-bearing pumps designated as model CP. These pumps are of the rotary, internal-gear, positive-delivery type, with an improved stuffing box and incorporating ball bearings. They are built to handle pressures up to 200 lb. per sq.in. on liquids with fair lubricating qualities. Four sizes range in capacity from 2 g.p.m. at 300 r.p.m. to 40 g.p.m. at 1,200 r.p.m.

Among the constructional features are: Ball bearings to absorb the thrust and radial loads of the rotor; compactness obtained by a standard mounting primarily arranged for end mounting with an optional bracket; and maintenance of priming by the use of upright ports.

Operating features include efficiency as high as 70 per cent on good grades of lubricating oil; direct-motor drive at speeds up to 1,200 r.p.m.; and ability to drive the pump in either direction of rotation.



A mounting bracket is optional for the Tuthill Model CP Oil Pump for hydraulic service

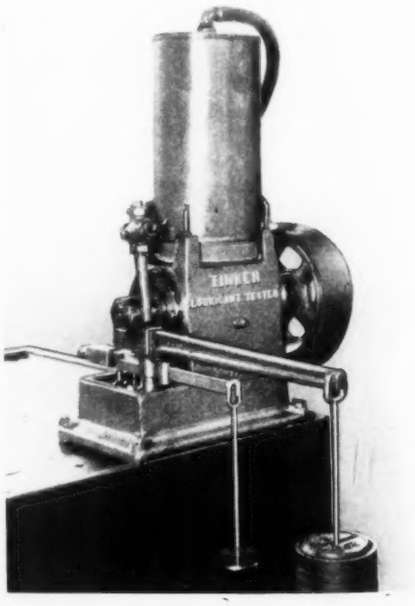
Timken Lubricant Tester

TESTING the load carrying capacity of lubricants is the function of the testing equipment announced by the Timken Roller Bearing Company, Canton, Ohio. If it should be desired, it can be used to obtain data on the relative efficiency of different bearing metals under various conditions of load, speed, temperature, or with different lubricants.

This testing equipment consists of a cast-iron base which supports the testing mandrel, two levers, and a container holding about a gallon of lubricant. The tank is mounted on top of the base, and just under it is an electric heater, used to raise the oil to any desired temperature up to 210 deg. F. The oil flows from the tank, over the test piece and to a sump in the base by gravity, the rate of flow being adjusted by means of a valve. From the sump, the oil is pumped back to the tank by a small pump located in the base, and belt driven from the testing mandrel. The latter extends through the base, and may be either direct or belt driven by a variable-speed, fractional-horsepower motor. The mandrel is mounted in two Timken bearings and is tapered at the test end to receive the tapered cup of a Timken bearing. This cup, which forms one of the test pieces, is held in place firmly by a nut on the end of the mandrel.

The lever system employs two levers, one above the other. The upper is called the load lever, and the lower the friction lever. The upper, which carries the test block, is pivoted on the knife edge mounted in the lower lever. The latter is also pivoted on a knife edge and is provided with a stop at the unloaded end. Through this arrangement the test block is always parallel to the revolving cup and the unit loading over the length of both pieces is always constant. The test block is a small piece of metal about $\frac{1}{2}$-in. square by $\frac{3}{4}$ in., hardened to Rockwell C-60 and ground. It is inserted in a notch in the loading lever and held in place by a wedge. Where bearing metals are to be tested, the test block or the cup, or both, can be made of the appropriate material.

With both test pieces in place, the driving motor or line shaft is brought



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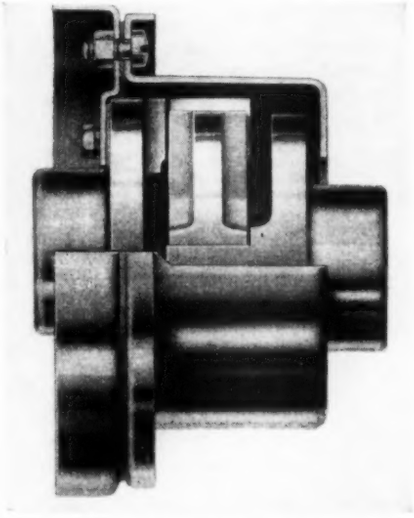
up to the desired speed, and the lubricant heated to the required temperature is allowed to flow over the test block. The loading lever is then loaded by means of weights until the desired unit pressure is obtained between the test pieces. A chart is furnished with the apparatus to give the necessary weights on the loading lever per 1,000 lb. of unit pressure. If only the load carrying capacity of the oil is to be determined, the test block is removed after 30 min. running, and examined for signs of scuffing. The degree of scuffing determines the relative load carrying capacity of the lubricant.

The coefficient of friction of the lubricant can also be determined.

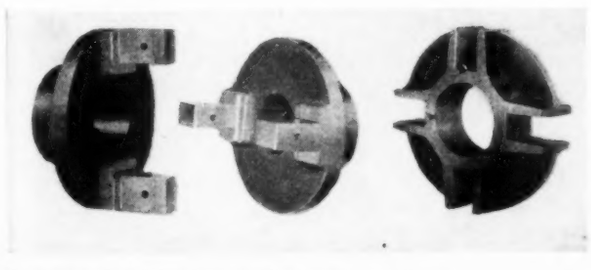
Francke Cross-Type Flexible Couplings

SHAFT misalignment up to $\frac{1}{16}$ in. can be taken care of by the Francke cross-type flexible coupling for small drives announced by Smith & Serrell, Globe Indemnity Bldg., Newark, N. J. This type of coupling is suitable for drives where spring cushion for load shocks is not important. It handles center misalignment and a limited amount of angularity. The three main parts are the two forged steel flanges and the cross. A pressed-steel grease cover is added.

The coupling is manufactured in four sizes having maximum bores from $1\frac{1}{8}$ to $1\frac{7}{8}$ in., and with ratings of 2 to 10 hp. at 1,150 r.p.m., or 3 to 15 hp. at 1,800 r.p.m.



Francke Cross-Type Flexible Coupling shown with the shafts misaligned



Two forged steel flanges and cast-iron cross of the Francke Cross-Type Flexible Coupling

"Korodless" Chrome-Nickel-Steel Wire Rope

PREFORMED construction is used for the "Korodless" wire rope announced by the Hazard Wire Rope Company, Wilkes-Barre, Pa. Material used for this rope is Nirosta austenitic chrome-nickel alloy steel and therefore is highly resistent to corrosion. It withstands temperatures up to 1,650 deg. F. Preforming the strands and wires in helical shape minimizes internal stress and allows the individual wires to lie side by side without undue internal friction.

Mercoid Type TU Furnace Control

A COMPLETE control unit providing incandescent electric ignition, protection, and regulation for automatic fuel burners has been placed on the market by The Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill. This type TU apparatus combines the control and ignition units mechanically so that operation of the control to start the burner depends upon proper operation of the ignition. In the complete circuit there are but five contacts to be made or broken, and all are of the enclosed Mercoid non-arcing type. Two are located in the TU control and the other three are respectively located in the thermostat, boiler control, and stack safety control. All switches must coordinate through the TU control to permit the burner to operate. The system has the following advantages:

(1) Fuel cannot enter the combustion chamber unless the igniters are in circuit and at the required temperature; (2) Only a limited amount of fuel can enter the combustion chambers unless combustion takes place; (3) If the flame fails the burner will shut down and start again after a set period; (4) If current fails, the burner will shut down until current is restored, and (5) The Pyratherm control returns to the off position after every operation.

Westinghouse Starters for Wound-Rotor Motors

FOR use where it is desired to have the complete control of the primary and the secondary of a wound-rotor induction motor in a single compact unit, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has developed the Class 12-600 control panels, a line of manually operated non-reversing starters and speed regulators.

These control panels are used with motors driving pumps, fans, and similar applications where the infrequency of operation makes manual control desirable.

The motor is started by closing the primary oil circuit-breaker with all

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Front view of Westinghouse Class 12-600 Manual Type Starter and Speed Regulator

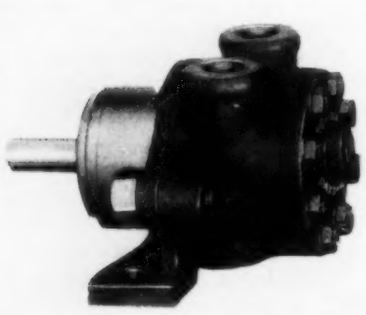
the resistance in the secondary circuit. The secondary drum is then gradually rotated through its successive contact positions.

The motor is stopped by returning the drum to the "off" position, by tripping the primary breaker, or by the use of a stop push button station in series with the undervoltage trip of the primary breaker.

Tuthill Model L Hydraulic Pump

A GEAR-TYPE, positive-delivery pump featuring a mechanical seal has been marketed by the Tuthill Pump Company, Chicago, Ill. This model L pump is available in six sizes, ranging in capacity from 3 to 180 g.p.h. Motor speeds up to 3,600 r.p.m. are taken care of in the smaller sizes and up to 1,800 r.p.m. in the larger sizes. Pressures up to 200 lb. per sq.in. can be developed in the larger pumps.

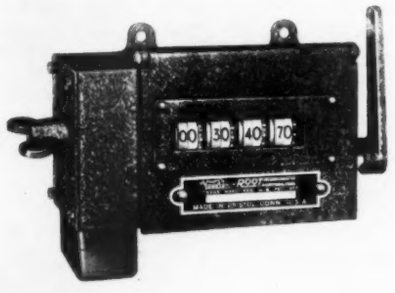
Among the construction features are: a mechanical seal that eliminates packing; flexibility of mounting through a standard design, primarily arranged for end mounting with an optional bracket for users desiring foot type of mounting; upright ports to maintain priming, and a ground housing bore to maintain the pressure.



Tuthill Model L Hydraulic pump with bracket, available in six sizes from 3 to 180 g.p.h.

Veeder-Root Predetermining Counter

A ROOT type predetermining counter, which can be set to any desired number within its capacity and will, when that number is reached, make or break contact in an electric contactor which is part of the counter, has been placed on the market by Veeder-Root, Inc., Hartford, Conn. The electrical circuit may be used to light a light, ring a bell, or stop the machine upon which the counter is installed.



Veeder-Root Predetermining Counter for indicating or stopping a machine after a specified batch has been run through

The counter itself has two distinct sets of figure wheels, one set having large black figures on white wheels (the counting wheels), the other, small black figures on metal wheels (the predetermining wheels). The metal wheels are set manually to the desired number. Upon operation of the counter, the counting wheels advance, the predetermining wheels subtract, and when the counting wheels reach the number which was predetermined on the metal wheels the electric contactor operates. To set the counting wheels to zero, it is only necessary to pull out the wing nut.

PUBLICATIONS

FOR THE ENGINEER'S LIBRARY

AIR EJECTORS. The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., is distributing folder D.M.F. 5299, covering briefly the use of steam-jet air ejectors in industries employing vacuum processes.

ENGINEERING ACHIEVEMENTS. The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has available Reprint 441 entitled "Engineering Achievements—1930," covering the developments in several fields.

FINISHING SPECIFICATIONS, AIRPLANE. The Sherwin-Williams Co., Aeronautical Sales Division, 291 Madison Ave., New York, N. Y., has prepared a booklet entitled "Airplane Finishing Specifications" giving a guide for the various surfaces to be covered and showing samples of colors and finishes.

MOTORS. The Master Electric Co., Dayton, Ohio, has issued price book No. 98 on single-phase, polyphase, and d.c. motors.

NICKEL, LITERATURE ON. The International Nickel Co., Inc., 67 Wall St., New York, N. Y., has prepared a 50-page compilation known as "Literature and Patent References to Nickel," which is now made available monthly to interested persons.

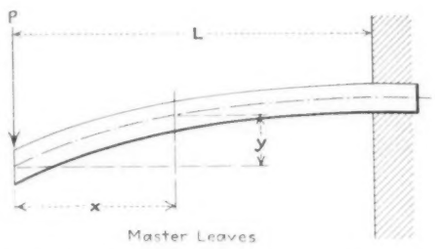
ROLLER BEARINGS. The Orange Roller Bearing Co., Orange, N. J., has published a revised edition of its engineering data sheets on roller bearings, showing staggered, heavy-duty radial bearings, journal bearings using solid roll construction, self-aligning thrust bearings, and tapered roller bearings. It gives 76 pages of specifications and capacities for these types.

STEELS. Darwin & Milner, 1258-64 West Fourth St., Cleveland, Ohio, is mailing its latest booklet on high-carbon, high-chromium steels marketed under the trade name of "Neor," and particularly recommended for press tools.

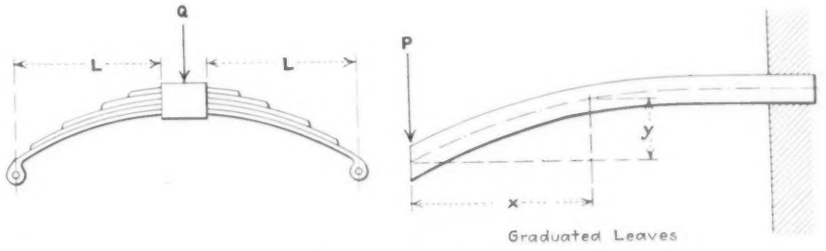
VARIABLE SPEED CONTROL, HANDBOOK OF. The Reeves Pulley Co., Columbus, Ind., is distributing a small handbook measuring 6¼x4 in., which is convenient as a textbook on variable speed control, and in addition contains a service manual and complete engineering data with reference to all sizes of Reeves variable-speed transmissions.

WIRE ROPE. The Hazard Wire Rope Co., Wilkes-Barre, Pa., has issued a pamphlet on "Korodless" wire rope made of chrome-nickel steel.

Leaf and Semi-Elliptic Springs



MASTER LEAVES of leaf springs are cantilever beams of uniform cross-section with the load concentrated at the free end



GRADUATED LEAVES of leaf springs act as a cantilever beam of uniform strength, that is, the same maximum fiber stress at all sections

The total load in a properly designed banded leaf spring should be distributed so that the maximum fiber stress will be the same for each leaf. In the following derivations:

Q = Total load carried by spring, applied at band
Q_m and Q_g = Vertical loads applied at spring shackle carried by master leaves and graduated leaves respectively
S = Maximum unit fiber stress
L = Length of spring from center of band to center of shackle bolt
N = Number of leaves
M = Bending moment
I/c = Section modulus
b = Width of each leaf
d = Depth or thickness of each leaf.

The subscript $_m$ is used to designate quantities pertaining to master leaves; subscript $_g$ to designate qualities pertaining to graduated leaves.

$$S = \frac{M}{I/c}$$

$$S_g = \frac{\frac{Q_g}{N_g}}{bd^2} L = \frac{6LQ_g}{bd^2N_g}$$

Similarly $S_m = \frac{6LQ_m}{bd^2N_m}$

Since, in the above, Q_m and Q_g are the loads at the shackle carried by the master leaves and graduated leaves, dividing each by its respective number of leaves will give the load per leaf in each case.

For equal stresses and all leaves of the save width and depth:

$$\frac{6LQ_g}{bd^2N_g} = \frac{6LQ_m}{bd^2N_m}$$

or

$$\frac{Q_g}{N_g} = \frac{Q_m}{N_m}$$

The graduated leaves, banded together, deflect as a cantilever beam of uniform strength, the maximum deflection of each leaf being equal to

$$\frac{6Q_gL^3}{N_gEbd^3} \quad (1)$$

The master leaves deflect as a cantilever beam of uniform cross-sectin, the maximum deflection being equal to $\frac{4Q_mL^3}{N_mEbd^3}$ (2)

As $\frac{Q_g}{N_g} = \frac{Q_m}{N_m}$, the difference between the deflection, Δ, of the master and graduated leaves will be:

$$\Delta_g - \Delta_m = 2 \frac{Q_mL^3}{N_mEbd^3}$$

Assuming the master leaves carry one-half the load Q, that *is*

$$\frac{Q_m}{N_m} = \frac{Q}{2N}$$

the depth of space to be provided between

Contributed by Gerardo Immediato, Professor, Brooklyn Polytechnic Institute

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Leaf and Semi-Elliptic Springs

the two parts of the spring before they are banded together, is

$$\Delta_g - \Delta_m = \frac{QL^3}{NEbd^3} \qquad (3)$$

As $$S = \frac{LQ/2}{N\,\frac{bd^2}{6}} = \frac{3QL}{Nbd^2}$$

or $$Q = S\,\frac{Nbd^2}{3L}$$

$$\Delta_g - \Delta_m = \frac{SNbd^2}{3L} \cdot \frac{NEbd^3}{L^3} = \frac{SL^2}{3Ed}$$

which gives the initial space between the leaves.

Deflection Δ' of master and graduated leaves caused by the pressure Q_b of the band is obtained by substituting $\frac{Q_b}{2}$ in Equations (1) and (2), the load being assumed evenly divided on each set of leaves. Hence:

$$\Delta' = \frac{3Q_bL^3}{N_gEbd^3} \qquad (4)$$

$$\Delta'_m = \frac{2Q_bL^3}{N_mEbd^3} \qquad (5)$$

From which

$$\Delta'_g = \frac{3N_m\Delta'_m}{2N_g}$$

Since total deflection produced by the band is equal to the depth of space, $\Delta'_g + \Delta'_m$ or $\Delta_g + \Delta_m$, provided between the two parts of the s pring:

$$\Delta_g + \Delta_m = \frac{3N_m\Delta'_m}{2N_g} + \Delta'_m$$

But

$$\Delta_g + \Delta_m = \frac{QL^3}{NEbd^3}$$

Hence:

$$\left(\frac{3N_m}{2N_g} + 1\right)\Delta'_m = \frac{QL^3}{NEbd^3}$$

or:

$$\Delta'_m = \left(\frac{2N_g}{3N_m + 2N_g}\right)\frac{QL^3}{NEbd^3}$$

From Equation 5:

$$\frac{2Q_bL^3}{N_mEbd^3} = \left(\frac{2N_g}{3N_m + 2N_g}\right)\frac{QL^3}{NEbd^3}$$

From which:

$$Q_b = Q\,\frac{N_gN_m}{N(3N_m + 2N_g)} \qquad (6)$$

Letting $K = \frac{N_m}{N}$ the ratio of the number of master leaves to the total number of leaves

$$N_g = N(1 - K)$$

Substituting:

$$Q_b = Q\,\frac{K(1 - K)}{K + 2}$$

which gives the pressure of the central band in terms of the total load.

The total deflection, Δ, of the spring is determined by taking the difference between the total deflection of the graduated leaves and that due to the band. Putting Q_b in terms of Q, there may be obtained from Equations 1 and 4:

$$\Delta = \Delta_g - \Delta'_g = \frac{6Q_gL^3}{N_gEbd^3} - \left(\frac{3N_m}{3N_m + 2N_g}\right)\frac{QL^3}{NEbd^3}$$

But:

$$\frac{Q_g}{N_g} = \frac{Q}{2N}$$

From which

$$\Delta = \frac{QL^3}{NEbd^3}\left(3 - \frac{3N_m}{3N_m + 2N_g}\right)$$

Which reduces to:

$$\Delta = \frac{QL^3}{NEbd^3}\left[\frac{6}{K + 2}\right]$$

As:

$$Q = \frac{Nbd^2S}{3L}$$

$$\Delta = \frac{L^2S}{Eb}\left[\frac{2}{K + 2}\right]$$

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